

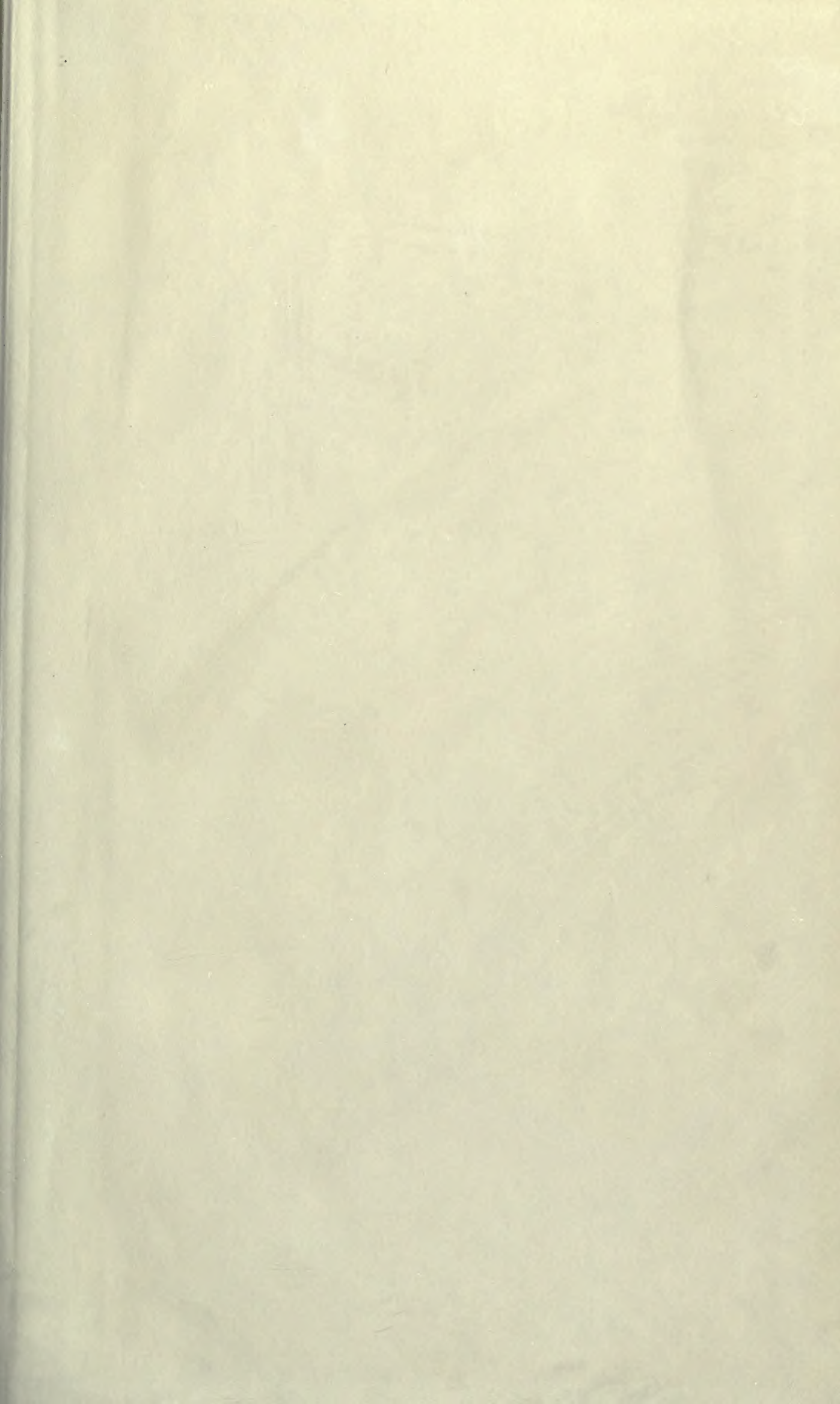
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Great Britain. Royal Commission  
Scientific Instruction and  
the Advancement of Science  
[Report]






















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# ROYAL COMMISSION

ON

## SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

VOL. I.

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FIRST, SUPPLEMENTARY, AND SECOND REPORTS,  
WITH  
MINUTES OF EVIDENCE AND APPENDICES.

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Presented to both Houses of Parliament by Command of Her Majesty.

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## CONTENTS.

	PAGE
COMMISSIONS - - - - -	iii
FIRST REPORT - - - - -	vii
SUPPLEMENTARY REPORT TO FIRST REPORT - - - - -	ix
SECOND REPORT - - - - -	xi
LIST OF WITNESSES - - - - -	xxxi
MINUTES OF EVIDENCE - - - - -	1
APPENDICES - - - - -	1
ANALYSES OF EVIDENCE - - - - -	61

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ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE  
ADVANCEMENT OF SCIENCE.

VICTORIA R.

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, To Our Right Trusty and Right Entirely Beloved Cousin William Duke of Devonshire, Knight of Our Most Noble Order of the Garter,—Our Right Trusty and Entirely Beloved Cousin Henry Charles Keith Marquess of Lansdowne,—Our Trusty and Wellbeloved Sir John Lubbock, Baronet,—Our Trusty and Wellbeloved Sir James Phillips Kay-Shuttleworth, Baronet,—Our Trusty and Wellbeloved Bernhard Samuelson, Esquire,—Our Trusty and Wellbeloved William Sharpey, Esquire, Doctor of Medicine,—Our Trusty and Wellbeloved Thomas Henry Huxley, Esquire, Professor of Natural History in the Royal School of Mines,—Our Trusty and Wellbeloved William Allen Miller, Esquire, Doctor of Medicine, Professor of Chemistry in Kings College, London,—and Our Trusty and Wellbeloved George Gabriel Stokes, Esquire, Master of Arts, Lucasian Professor of Mathematics in the University of Cambridge, Greeting :

Whereas We have deemed it expedient for divers good causes and considerations that a Commission should forthwith issue to make Inquiry with regard to Scientific Instruction and the Advancement of Science and to Inquire what aid thereto is derived from Grants voted by Parliament or from Endowments belonging to the several Universities in Great Britain and Ireland and the Colleges thereof and whether such aid could be rendered in a manner more effectual for the purpose.

Now Know Ye that We reposing great Trust and Confidence in your Ability and Discretion have nominated constituted and appointed and do by these Presents nominate constitute and appoint you the said William, Duke of Devonshire—Henry Charles Keith, Marquess of Lansdowne—Sir John Lubbock—Sir James Phillips Kay-Shuttleworth—Bernhard Samuelson—William Sharpey—Thomas Henry Huxley—William Allen Miller—and George Gabriel Stokes—to be Our Commissioners for the purposes of the said Inquiry.

And for the better enabling you to carry Our Royal Intentions into effect We do by these Presents authorize and empower you or any three or more of you to call before you or any three or more of you such persons as you may judge necessary by whom you may be the better informed of the matters herein submitted for your consideration and also to call for and examine all such Books Documents Papers or Records as you shall judge likely to afford you the fullest information on the subject of this Our Commission and to Inquire of and concerning the Premises by all other lawful ways and means whatsoever.

And Our further Will and Pleasure is that you or any three or more of you do Report to Us under your Hands and Seals (with as little delay as may be consistent with a due discharge of the Duties hereby imposed upon you) your opinion on the several matters herein submitted for your consideration, with power to certify unto Us from time to time your several proceedings in respect of any of the matters aforesaid, if it may seem expedient for you so to do.

And We do further Will and Command and by these Presents ordain that this Our Commission shall continue in full force and virtue and that you Our said Commissioners or any three or more of you shall and may from time to time proceed in the



COMMISSION.

execution thereof and of every matter and thing therein contained although the same be not continued from time to time by adjournment.

And for your assistance in the execution of these Presents We do hereby authorize and empower you to appoint a Secretary to this Our Commission to attend you whose services and assistance we require you to use from time to time as occasion may require.

Given at Our Court at Saint James's, the Eighteenth day of May 1870, in the Thirty-third year of Our Reign.

By Her Majesty's Command,

H. A. BRUCE.



ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE  
ADVANCEMENT OF SCIENCE.

---

*VICTORIA R.*

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, To Our Trusty and Well-beloved Henry John Stephen Smith, Esquire, Master of Arts, Savilian Professor of Geometry in Our University of Oxford, Greeting :

Whereas We did by Warrant, under Our Royal Sign Manual, bearing date the Eighteenth Day of May, One Thousand Eight Hundred and Seventy, appoint Our Right Trusty and Right Entirely Beloved Cousin, William, Duke of Devonshire, Knight of Our Most Noble Order of the Garter, Our Right Trusty and Entirely Beloved Cousin, Henry Charles Keith, Marquess of Lansdowne, together with the several Gentlemen therein named, to be Our Commissioners to make Inquiry with regard to Scientific Instruction and the Advancement of Science, and to inquire what aid thereto is derived from Grants voted by Parliament, or from Endowments belonging to the several Universities in Great Britain and Ireland, and the Colleges thereof, and whether such aid could be rendered in a manner more effectual for the purpose : And whereas since the issue of the said Warrant William Allen Miller, Doctor of Medicine, one of the Commissioners thereby appointed, hath deceased :

Now Know Ye, that We, reposing great Trust and Confidence in Your Zeal, Discretion, and Integrity, have authorized and appointed, and do by these Presents authorize and appoint you the said Henry John Stephen Smith to be a Commissioner for the purpose aforesaid, in addition to, and together with, the Commissioners now acting under the above-mentioned Royal Warrant.

Given at Our Court at Saint James's the First Day of December 1870, in the Thirty-Fourth Year of Our Reign.

By Her Majesty's Command,  
H. A. BRUCE.

Professor Henry John Stephen Smith, M.A.,  
To be a Commissioner for inquiring into  
Scientific Instruction and the Advancement of Science.

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# FIRST REPORT.

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TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

WE, the Commissioners appointed by Your Majesty to make Inquiry with regard to Scientific Instruction and the Advancement of Science, humbly beg leave to present to Your Majesty the following First Report :

1. We have heard the evidence of witnesses in reference to the following subjects, forming part of our inquiry, viz. the Royal School of Mines, the Geological Survey of Great Britain and Ireland, the Mining Record Office, and the Museum of Practical Geology, at present located in Jermyn Street; and also concerning the Royal College of Chemistry, at present lodged in a building in Oxford Street; which institutions are under one head, entitled Director-General of the Geological Survey of Great Britain and Ireland and Director of the Royal School of Mines.

2. There is no necessary connexion between the direction of the Geological Survey of Great Britain and Ireland and the government of the Royal School of Mines.

3. The Royal School of Mines and the Royal College of Chemistry, which practically constitute one School of Pure and Applied Science, are not organized in such a manner as to enable them to perform efficiently the work for which they were originally, or are, at present, intended. We base this conclusion upon three grounds: (*a.*) the absence of a chair of Mathematics, (*b.*) the absence of Physical or Biological Laboratories in which students can receive practical instruction, (*c.*) the insufficiency of accommodation in the Royal College of Chemistry.

4. The Officers of the Geological Survey are greatly hindered in their work by want of accommodation; for although their number has been quintupled during the last 20 years, the space originally allotted to them has not been increased.

5. The space allotted to the Mining Record Office is already insufficient for the proper reception and arrangement of the valuable series of documents accumulated there; and for the accommodation of the public who desire to consult them.

6. The collections in the Museum of Practical Geology require greater space for their proper display than is at present afforded.

7. In order to provide a remedy for the inconveniences which have been enumerated, we recommend: (*a.*) That the Building in Jermyn Street be given up to the Survey and to the Museum, with the reservation that the Lectures to Working Men be delivered as heretofore in the Theatre: (*b.*) That the building in Oxford Street be vacated by the Royal College of Chemistry; and (*c.*) That the Mining Record Office be lodged with the Statistical Department of the Board of Trade; or, failing accommodation there, in the building now occupied by the Royal College of Chemistry.

8. Without expressing any opinion, at present, as to the policy of Government Schools of Science, your Commissioners, having to deal with the Royal School of Mines and the Royal College of Chemistry as Institutions which have existed for 20 years, and which, during that period, have turned out a large number of well-instructed Students, consider that such steps should be taken as may be necessary to render their Teaching thoroughly efficient.

9. With this object we recommend that the two Institutions be consolidated; that Mathematics be added to the Courses of Instruction now given; and that sufficient Laboratories and Assistance for giving Practical Instruction in Physics, Chemistry, and Biology, be provided.

10. The Institution thus formed (herein-after called the "Science School") may be conveniently and efficiently governed by a Council of Professors, one of that body acting as Dean.



11. We have further heard evidence concerning the Buildings at South Kensington, now nearly completed, and intended for the reception of a projected School of Naval Architecture and Science; and we recommend that the Science School should be accommodated in these buildings. We have given careful attention to the considerations in favour of the retention in Jermyn Street of the Technical Instruction in certain Branches, but we are of opinion that these considerations are outweighed by the great advantages to be derived from concentration.

12. We have further heard evidence concerning the Royal School of Naval Architecture and Marine Engineering, now conducted at South Kensington; and we recommend that the theoretical instruction of that school should in future be given in the Science School, the general instruction in Mathematics, Physical Science, and Mechanical Drawing, thus becoming common to both schools. We also recommend that no additional buildings, and no reconstruction of the temporary buildings at present occupied by the Royal School of Naval Architecture and Marine Engineering, should be undertaken, until a Further Report has been received from this Commission.

13. We have further heard evidence concerning the system of teaching Elementary Science under the Science and Art Department; and we are of opinion that the Quality of the Instruction given under this Department would be greatly improved if the teachers received Practical Instruction in Elementary Science. Such instruction has, indeed, already been given with marked advantage, although only to a limited extent. The Science School will be available for the instruction of many Science Teachers throughout the country; but we reserve for a Further Report any expression of opinion as to the precise character of such Instruction, and as to the conditions under which it shall be accessible.

14. The organization of, and accommodation required by the Science School (including its Technical Branches), and the Royal School of Naval Architecture, will be dealt with in detail in a Further Report.

All which we humbly submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE.  
LANSDOWNE.  
JOHN LUBBOCK.  
J. P. KAY-SHUTTLEWORTH.  
B. SAMUELSON.  
W. SHARPEY.  
THOMAS H. HUXLEY.  
G. G. STOKES.  
HENRY J. S. SMITH.

J. NORMAN LOCKYER,  
Secretary.  
9th March 1871.



# SUPPLEMENTARY REPORT

TO

## FIRST REPORT.

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TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY :

WE, the Commissioners appointed by Your Majesty to make inquiry with regard to Scientific Instruction and the Advancement of Science, humbly beg leave to present to Your Majesty the following Report on the Organization of the Science School referred to in our First Report, and on the accommodation of that School in the new buildings at South Kensington.

### I. ORGANIZATION.

1. Your Commissioners recommend that the Science School be represented before the Board of the Science and Art Department by its Dean, as the Royal School of Mines has been hitherto represented by its Director.

2. We recommend that the Council of Professors shall have power, subject to the approval of the Board, to provide for the due maintenance of discipline in the general school and technical schools; the discipline of the students of the Royal School of Naval Architecture and Marine Engineering remaining under the Principal of that School.

3. We consider that such modifications as to the conditions of admission to the courses, as well as such re-arrangement of the courses as may be rendered expedient by the consolidation of the Schools recommended in the First Report of the Commission, should be considered and reported on to the Committee of Council on Education by the Council of Professors, due regard being had to the maintenance of its character as a School for Special Scientific Instruction. Such re-arrangement should admit of provision being made for the continuance and extension of the instruction given to Elementary Science Teachers during the summer months.

4. With reference to the assistance required by the Professors, we recommend that this subject should also be considered by the Council of Professors, and reported on by them to the Committee of Council on Education, due regard being had to the necessity of practical instruction, and to the suggestion in the previous paragraph concerning the instruction to be given to Science Teachers.

### II. ACCOMMODATION.

5. Your Commissioners find that the new buildings at South Kensington will afford sufficient space as regards lecture theatres, class rooms, and laboratories, for the theoretical and practical instruction of a large accession of students. A Committee of Your Commissioners have inspected the new buildings with special reference to the accommodation that will be afforded, and the Secretary, at their request, has applied to the several Professors for information as to the space that they require.



The Committee having reported the results of their inspection and inquiry, Your Commissioners suggest the following general appropriation, considering that the detailed allotment of rooms had better be left to the Professors themselves :

- Basement - Physics, Metallurgy, Chemistry.
- Ground Floor - School of Naval Architecture, General Lecture Room,  
Mathematics, Applied Mechanics, &c.
- First Floor - Physics and Chemistry.
- Second Floor - Chemistry.
- Third Floor - Biology, Mineralogy, Mining, Geology, Physics, Chemistry  
(open air work).

All which we humbly submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE.  
 LANSDOWNE.  
 JOHN LUBBOCK.  
 J. P. KAY-SHUTTLEWORTH.  
 B. SAMUELSON.  
 W. SHARPEY.  
 G. G. STOKES.  
 HENRY J. S. SMITH.  
 \*T. H. HUXLEY.

\* The Chairman has been authorized by Professor Huxley to affix his name to this Supplementary Report, and J. NORMAN, Esq., Secretary.

28th February 1872.

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## SECOND REPORT.

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TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

WE, the Commissioners appointed by Your Majesty to make inquiry with regard to Scientific Instruction and the Advancement of Science, humbly beg leave to present to Your Majesty the following Report on Scientific Instruction in Training Colleges and Elementary Day Schools under the Education Department, and in Science Classes under the Science and Art Department.

### I.—SCIENTIFIC INSTRUCTION IN TRAINING COLLEGES AND ELEMENTARY DAY SCHOOLS.

#### STATE OF INSTRUCTION PRIOR TO THE INTRODUCTION OF THE REVISED CODE.

1. In dealing with the Scientific Instruction in Training Colleges and Elementary Day Schools, Your Commissioners have, in the first place, enquired what provision was made for such instruction before the introduction of the Revised Code in 1861.

2. With respect to the *Training Colleges*, we find that instruction in the elements of science was given to students in their second year. The Committee of Council on Education made grants in aid of the stipends of masters specially qualified to teach the elements of science. In some training colleges a sound, though limited, instruction in the elements of some branches of physical science was thus added to the usual instruction in elementary mathematics. In the model schools attached to the training colleges the students were practised in teaching the rudiments of science, chiefly, though not exclusively, in illustration of appropriate lessons in reading and geography, with obvious advantage in the increase of the intelligence of the scholars and of their interest in their schoolwork. Such instruction enabled skilful teachers to make the lessons the occasion of conveying important explanations of natural phenomena, and some rudimentary acquaintance with the most easily understood laws of nature; although neither in the training colleges, nor in the model schools attached to them, were the methods of communicating the rudiments of scientific knowledge by means of systematised object lessons always sufficiently cultivated. The scientific instruction received by the teachers in the training colleges was, however, of great value irrespectively of such use in the rudimentary lessons; for all such knowledge tends to enlarge the intelligence of the teacher, and enables him to give better and more interesting instruction.

3. With respect to the *Elementary Schools*, we find, as a consequence also of the instruction thus afforded to the teachers, that it was the practice formerly, more generally than at present, in the best of such schools to give, either in separate oral lessons or as parts of the illustrations of the reading lessons, general outlines of physical geography, some of the more prominent facts in astronomy, and instruction in those parts of domestic and social economy which affect the health of families and communities. In some remarkable schools more extensive instruction of this character was given, just as more advanced literary culture was given in others. Under Professor Henslow, for instance, botany was found an excellent method of training the powers of observation and the intelligence. In like manner, in a school comprising, besides the children of labourers, the children of small farmers and tradesmen, Dean Dawes\* gave instruction in applied mathematics and mechanics, as well as in some of the elements of experimental physics.

4. It is, no doubt, true that the success obtained in these schools was due to the guidance and the direct personal teaching of men of superior education, having an earnest and even singular interest in the attainment of this result, and a capacity much beyond the average of that of elementary school teachers. We concur, however, in Canon

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\* See Canon Moseley's Report on King's Somborne School in the "Minutes of the Committee of Council on Education," for 1847-48, Vol. I., p. 7.



Moseley's opinion that, even without such exceptional advantages, the system pursued in these schools may be conducted by well-trained teachers of average capacity with good effect. Indeed, we have the evidence of highly competent authorities to show that the scientific instruction which was given by ordinary elementary school teachers, before the introduction of the Revised Code in 1861, was in many cases sound and valuable in itself and beneficial to the pupils.

5. In order to show more distinctly the state of Scientific Instruction in Training Colleges and Elementary Schools before 1861, we proceed to give some extracts from the evidence of the Rev. Dr. Rigg, Principal of the Wesleyan Training College, Westminster, and of the Rev. Canon Cromwell, Principal of St. Mark's College, Chelsea.

6. In the earliest schemes of the Training Colleges, arrangements were made that the students should have such a basis of scientific instruction as, in the words of Dr. Rigg, would enable them to give the children in "elementary schools information " on various points of science which at that time were not generally taught in the " school reading books, and, therefore, could only be done by oral lessons. The subjects " were such as these: the structure and habits of remarkable animals and plants, short " explanations of various scientific principles involved in manufacturing processes, as, " for instance, the construction of some common machines, involving, of course, the " principles of mechanics; together with points in physiology, as bearing on the pre- " servation of health; instruction with regard to our own body and its organs; the " atmosphere, and other such topics." In order to prepare the teachers for giving such instruction, the promoters of the Wesleyan Training College at Westminster, at its foundation, spent 200*l.* " in purchasing scientific apparatus." " Pure and mixed mathe- " matics " were, " up to 1862, taught to an extent about equal to that required for a B.A. " degree of the London University. One half of the second year's male students received " some sort of systematic instruction in the elements of physics, and the other half in " mathematics."

7. The Rev. Canon Cromwell states, that, " between 1851 and 1861, there was " a very great change both in the amount of assistance that the Government gave, and " also in the character of the candidates who came for admission. The Minutes of " 1846 began to tell on the Colleges. Those minutes provided for a system of appren- " ticeships to schoolmasters all over the country. The cleverest boys in the schools " were selected to become pupil teachers. They received special instruction at the " hands of masters, and for that instruction the masters were paid a certain sum by the " Government. The result was, that the schoolmasters were stimulated to give as much " instruction as they possibly could to their pupils, and the pupils came up to the " College, in 1851 and subsequent years, with a very fair amount of mathematical " knowledge. They came with a thorough knowledge of arithmetic, in all its branches, " applied as well as theoretical, with a knowledge of algebra as far as simple equations, " and sometimes as far as quadratic equations, with a knowledge of the first two books " of Euclid, as a necessary condition of admission, and very often they brought up four " books of Euclid, and not unfrequently they came up with some knowledge of Latin. " There was here a good foundation upon which subsequent knowledge could be built. " Such were the qualifications for admission into the college between the years 1851 and " 1861; and during that time instruction was given in applied mechanics, in chemistry, " in hydrostatics, and in optics. A laboratory was established, and a regularly paid and " competent teacher was employed. Models of all the ordinary machines were bought, " and the students were instructed in applied mechanics. Drawing was so taught as to " be applied to the arts. The drawing master was an engineer of considerable experience, " and a perfect enthusiast in the way of practical education." " I should say that in " the year 1854, at the representation, I think, of Canon Moseley, who was once " Professor of Mathematics at King's College, special encouragement was given to the " teaching of applied science in Normal Colleges, by the establishment of lectureships " for competent instructors, and those lectureships could not be obtained unless the " lecturers passed a special examination before, I think, the Civil Service Commissioners. " Every lecturer who did so pass (for instance, in chemistry, or in applied mechanics, or " in any other subject of science) received 100*l.* a year from Government, in addition to " the salary which he received from the Council or Committee of his College. That " grant gave a very great stimulus to scientific instruction in the various Colleges. " That 100*l.* a year was not paid, however, unless the lecturer continued to give satisfac- " tion at the annual inspection of the College by one of Her Majesty's Inspectors. One " of the Inspectors during a part of that period was Professor Moseley, and during " the other part of that period Bishop Temple was Inspector."

Questions  
7903-8031,  
pp. 542-551.  
Questions  
8032-8099,  
pp. 551-559.  
Qu. 8033.

Qu. 8033.

Qu. 7904.



These lecturers "taught" solely in the College, and it was a condition they should "have a fair salary from the College as well as the 100% augmentation from the Government." "A College of 30<sup>b</sup> could not have more than one lecturer, and a<sup>b</sup> College of 100 not more than three lecturers." Qu. 7905. Qu. 7906.

#### INFLUENCE OF THE REVISED CODE UPON SCIENTIFIC INSTRUCTION.

8. We now proceed to consider the influence of the Revised Code of 1861, which introduced the system of individual examination, proposed in the Minute of 1853. While we approve the principle that the grants to schools should be determined to a considerable extent by the results of individual examination, we are of opinion that the limitation of such examination to the subjects of Reading, Writing, and Arithmetic unfortunately narrowed the instruction given in Elementary Schools; and that this change, together with the lower standard adopted in the training and examination of Pupil Teachers, and the curtailment of the Syllabus of the Training Colleges, exercised a prejudicial effect on the education of the country.

9. Dr. Rigg observes that "if the Revised Code is considered to be identified merely with the principle of individual examination in schools, I do not doubt that, from the principle of individual examination in schools, very good results have followed; but that principle was recommended before the Revised Code was in existence." It had been previously recommended "that a certain proportion of the grant should be made dependent on individual examination," and a Minute had been drawn for that purpose in 1853, but not carried out; "therefore, I do not consider that the principle of payment after ascertainment of results was really the principle of the Revised Code. I think that the principle of the Revised Code was to restrict education as far as possible within the limits of those particular subjects on which payment was made. That was the governing principle of the Revised Code, especially as originally propounded in Parliament, and to discourage everything in the nature of higher education, and broader education, and deeper education; that it looked, in fact, to mechanical instruction in what are considered the three principal rudimentary branches. I have no doubt at all that many children were more or less neglected, and that in order to cure that, individual examination was necessary; but I believe that individual examination might have been had without the general spirit and scope of the Revised Code." Qu. 8083.

Dr. Rigg also expresses his opinion that the tendency of the Revised Code was to compress the school age within very narrow limits, to discourage children attending school after 10 or 11 years of age, and to restrict the education of the children within hard and narrow lines." Qu. 8084.

10. The same witness also states, that though, between 1862 and 1867, scientific instruction was never given up in the Training Colleges, "there is no doubt that from 1862 everything suffered; our infant school processes suffered, and everything suffered more or less, perhaps owing as much to panic as to anything else; but many things were sacrificed in, I do not say the majority, but in a considerable proportion, of our schools, to what were considered to be paying results." Qu. 8034.

11. Canon Cromwell confirms this evidence by stating, "that before 1861 the inspectors were called upon to inspect in all the subjects which were taught in a school; but after 1861, as a rule, they did not examine except in those subjects which were prescribed by the Code of 1861 and 1862—reading, writing, and arithmetic, and some religious knowledge. That change caused the schoolmasters to cease from giving instruction in extra subjects." Qu. 7930.

12. In reference to Pupil Teachers and Training Colleges, Canon Cromwell states:— "In the year 1861 a great change took place. The amount of instruction encouraged and paid for in the Training Colleges was very much reduced, and those lectureships to which I have referred were all of them abolished. The Government has, for many years past, been in the habit of drawing up a Syllabus of the course of instruction to be followed in the various Training Colleges. That syllabus was very much curtailed in 1862. The special subjects, such as applied mechanics, physical science, and the higher mathematics, were all struck out, and the syllabus was reduced almost to the level that might be attained by a really clever boy in the first class of a good national school. The students were expected to have a certain amount of religious knowledge, geography, history, arithmetic, and two books of Euclid. At the same time, the amount of instruction given to pupil teachers all over the country was also diminished, because no longer were the masters and mistresses paid for giving instruction to pupil teachers, and the result was, that, in Qu. 7907.



" many cases, scarcely any instruction has since been given. In most of the Normal Colleges, certainly at St. Mark's, and at Durham, where I was at the time, we struggled against that reduction in the subjects of the syllabus. We tried to retain the higher standard as long as it was possible with the students; we taught more things in the Colleges than the Government required; but year by year we found that the pupils who came in were worse and worse prepared, so that, at last, it was almost impossible to give anything more than the Government syllabus demanded."

Qu. 7908. " The syllabus is almost the same that it has been since 1861. Under it, the pupil teachers, instead of being required to bring two books of Euclid into the College, are only expected to bring up one book, and, instead of being expected to go through simple equations, they are now not expected to have any knowledge of algebra; so that the whole standard, everywhere, from the National School up to the Training College, has been reduced in amount, making it extremely difficult for us to continue the higher style of education in the Training Colleges. The time given to the instruction of pupil teachers in each week was also reduced. Prior to 1861, the pupil teachers were to receive one and a half hours' instruction on five days in the week, or seven and a half hours' instruction in each week; but, subsequently to 1861, a pupil teacher was only required to have one hour a day, or five hours a week. But time was not the only thing that was reduced; the teachers had not the same interest or zeal in the matter, because they were no longer paid as before."

Qu. 7909. " The pupil teachers might be instructed in the evening school along with the ordinary scholars, and that almost reduced the instruction to the level of an ordinary evening school."

13. The general apprehension inspired by all these changes, rendered the profession of schoolmaster less popular. The education of the pupil teachers was generally impaired, fewer candidates were apprenticed, and the number of those who resorted to the Training Colleges fell off. So that, Canon Cromwell says, " in the spring of 1869, instead of having 50 or 60 candidates for admission, we had, I think, only 34; and the College, instead of having 104 inmates, had less than 80 inmates. The Highbury Training College and the Chichester Training College were entirely closed; and the Colleges at Chester, York, Durham, Culham, Peterborough, and Exeter were scarcely half full. It was the case almost all over the country. The number of pupil teachers fell [at one period] from 13,000 to 6,000."

14. It is right, however, to point out that the consequences to which we have referred have been in part obviated by the operation of the system introduced by the Science and Art Department. So strong was the conviction of the Principals of certain of the Training Colleges, that elementary scientific knowledge was of great value to their students, that, in the absence of any assistance from the Education Department, they prepared their students for the May Examinations of the Science and Art Department, and permitted them to attend those examinations, thus qualifying themselves to earn grants under that Department.

Qu. 8083. 15. Thus, Dr. Rigg, speaking of the Wesleyan Training College at Westminster, says, that " in 1868, 1869, and 1870, the encouragement given by the Science and Art Department had begun to tell so powerfully, that instruction was fully restored in those scientific subjects, and some classes of students in the Westminster Training College were presented for the May Examinations of the Science and Art Department, and there will be a large number of them this year. The subjects selected for such examinations were physical geography, inorganic chemistry, elementary mathematics, and, in part, theoretical mechanics, and, this year, animal physiology. Those were prepared as being in some relation to the ordinary course of training presented by the Committee of Council on Education. The female students attempted nothing more than physical geography. Of course, that includes some instruction about the habits of plants, and about geology, and so forth. Some of the male students took four subjects, but the majority of them took only three."

16. Among the impediments to higher instruction in Training Colleges, besides the restricted range of the syllabus of studies, the absence of sufficient indication of the objects and limits of the examination papers is also the subject of important evidence from Dr. Rigg, and Canon Cromwell. Dr. Rigg represents that the Principals or Committees of Training Colleges have slender opportunities of making any " deliberate representations upon the subject to the Committee of Council." We are of opinion that occasional conferences on the syllabus might be useful, in giving the Department the aid of the practical experience of Principals, of Inspectors, and of Men of Science.

Qu. 8035.

Qu. 7951.

Qu. 8039,  
8040.



## THE NEW CODE OF 1871.

17. The New Code of 1871 does not affect the Training Colleges except so far as relates to religious inspection, and, from the evidence we have taken, we fear it will practically have little effect in widening the range of the education in elementary schools; that, as heretofore, the grants will, in future, be almost wholly given for reading, writing, and arithmetic; and that little encouragement will be afforded to the study of other subjects, even of history and geography.

18. It is true that grants of 3s. each are offered for proficiency in any two "extra subjects," under which term the Committee of the Privy Council on Education include everything except reading, writing, and arithmetic; but no children can earn these grants unless they are presented for examination in Standards IV.-VI., and pass a satisfactory examination in two out of the three compulsory subjects. Now, no child can be presented in the first standard until it is seven years old, so that the fourth will not be passed before the 11th year. For children of this age, the standards for the extra subjects, as laid down in the schedule of the New Code (p. 19.), seem to us very low. For instance, in geography the requirements are "a knowledge of the chief divisions of the world" and of the meaning of a map; while, in history, the master is instructed to "select" some chief event of importance in the history of England since the Conquest, and "let the children know something about it in detail." The requirements in the other extra subjects are not more difficult, and we are of opinion that such examinations might easily be passed by children at an earlier age than 11, and that the grants for extra subjects might, therefore, be advantageously thrown open at an earlier period—at any rate, to children who are going in for the third standard. Such a modification in the Code could not interfere with the instruction in reading, writing, and arithmetic, because the grant for extra subjects is contingent on success in two out of the three elementary subjects. As regards the younger children, also, we consider that Her Majesty's Inspectors should be directed to satisfy themselves that such elementary lessons are given as would prepare the minds of the children for the more advanced instruction which will follow.

19. We now come to the case of the elder children. Those who are presented in Standards IV.-VI. may offer themselves for examination, and, if successful, will earn the grants of 3s. each offered for proficiency in any two extra subjects. But, on the other hand, it appears to us that the encouragement thus apparently held out is rendered, to a great extent, illusory by the other conditions of the Code. To make this clear, it is necessary to state the manner in which, under the Code, grants are earned. The sum of 6s. is granted for each scholar on account of attendance, and 4s. each for the three subjects, making 12s. for reading, writing, and arithmetic. Thus, each scholar can earn 18s., apart from extra subjects, and as 14s. a head (or 15s. where music is taught) is the maximum payable, it is evident that schools can earn the whole amount without teaching any of the so-called extra subjects.

20. Indeed, it is obvious that if 75 per cent. of the children pass in reading, writing, and arithmetic, the school will earn the maximum grant, and, in fairly good schools, this amount of success has been, and we doubt not will be, attained without difficulty. Nor do we think it would be desirable that the standards should be raised in such a manner as to reduce the passes below this proportion; such a course would, we think, tend to discourage both the masters and pupils. The last Report of the Education Department shows\* that the existing schools did, in fact, earn last year almost the full grant, without any assistance from the extra subjects, and those schools which are unable to pass the children in the elementary subjects are certainly not likely to be successful in others of a more advanced character.

21. We do not wish to underrate, in any way, the necessity of careful instruction in reading, writing, and arithmetic, as the very foundation of education; but we do not believe that the introduction of extra subjects would in any way interfere with it. Mr. Lingen, then Secretary to the Committee of Council on Education, stated before Mr. Samuelson's Committee on Scientific Instruction, in answer to Mr. Dixon,† that those schools in which extra subjects are introduced are most successful in teaching reading and writing; and Mr. Moseley, in his Report on the King's Somborne School, expressed it as his opinion that the slowness with which children in our elementary schools learn to read

\* The total number of children qualified to earn grants was 1,090,611 (l. c. p. viii.). The number presented for examination was 887,041, of whom 810,911 passed in reading, 792,480 in writing, and 707,381 in arithmetic.

† *Minutes of Evidence taken before the Committee*, Qu. 756, p. 40.



34. We have recorded the evidence which has been given as to the changes in the conditions of the grants of the Committee of Council on Education which interfered with the efficiency of the instruction of Pupil Teachers in Elementary Schools, and caused the colleges to be supplied with students imperfectly prepared, which deprived them of a staff of special teachers, which curtailed the syllabus, and reduced the standard of acquirements in the examination for certificates. In so far as these circumstances affect the preparation of teachers on subjects other than scientific, they fall within our province only because they militate against the introduction of the elementary forms of scientific

*Winchester Training College for Schoolmasters.* — “The students of the second year . . . . . fell below a fair standard in mental arithmetic (although in this subject they gained more marks than many colleges), grammar, geography, and Euclid.”

*York and Ripon Training College for Masters.* — “The students of the second year . . . . . fell below a fair standard in . . . . . mental arithmetic, English grammar, geography, history, and Euclid.”

Extracts from a Report, for the Year 1870, by Her Majesty’s Inspector, Matthew Arnold, Esq., D.C.L., on the Training Schools of the British and Foreign School Society in the Borough Road for Schoolmasters, and at Stockwell for Schoolmistresses :—

*Borough Road College* . . . . . “For the second year students I find that the weak points are geometry, mental arithmetic, geography, and grammar. Less than 27 per cent. reached the mark of *fair* in Euclid, less than 14 per cent. in mental arithmetic, less than 5 per cent. in geography, and less than 3 per cent. in grammar. The results in these matters with the second year students of 1869 were better as regards Euclid and grammar, slightly worse as regards mental arithmetic and geography. Grammar, mental arithmetic, and economy are the weak points with the first year students this time.” . . . . . “With the *Stockwell* students also mental arithmetic is a weak point.”

Extracts from the Report, for the Year 1870, by Her Majesty’s Inspector, Scott Nasmyth Stokes, Esq., on the Roman Catholic Training School at Hammersmith for Schoolmasters :—

“The results of the ordinary examination held in December 1870, show that the second-year students obtained . . . . . *moderate* marks for history and Euclid; and they were found *imperfect* in mental arithmetic, grammar, and economy, since in those subjects none got even fair marks.”

“The students of the first year . . . . . were judged to be imperfect in mental arithmetic, grammar, and economy.”

Extract from the Report, for the Year 1870, by Her Majesty’s Inspector, James Cumming, Esq., LL.D., on the Free Church Training School, Edinburgh :—

“In considering the tabulated results of the examination in reference to the different subjects of study, the conclusions are partly satisfactory, and partly of a somewhat perplexing if not startling nature. In regard to the most essential subjects, the reading, writing, arithmetic, religious knowledge, and teaching power, the results are generally good, with, perhaps, some deduction in the penmanship of the female students. But according to the table, while in composition 88 per cent. of the senior females, and 84 per cent. of the junior females, as well as 66 per cent. of the junior male students, have passed creditably, not one individual of the senior male students has passed as excellent, as good, or even as fair; the per-centage is an absolute blank. A similar result appears as to geography. Such a result would require very anxious consideration and inquiry on the part of the conductors of the institution, and would no doubt receive it, were it not so very extraordinary as to excite the suspicion that there must be some mistake. I am assured that this is not the case, and I can therefore only direct attention to the striking fact.”

TABULATED RESULTS OF EXAMINATION, CHRISTMAS, 1870.  
Per-centage of Candidates examined who obtained Marks of Excellent, Good, or Fair.  
Male Students of the Second Year.

Training School.	Mental Arithmetic.	Grammar.	Geography.	Penmanship.	Euclid.
Bangor - - - - -	8·33	—	—	75·00	58·33
Battersea - - - - -	29·73	10·81	43·24	48·65	37·83
Borough Road - - - - -	13·33	2·22	4·44	75·55	26·66
Carmarthen - - - - -	12·50	—	25·00	25·00	25·00
Carnarvon - - - - -	—	—	—	27·27	—
Chelsea - - - - -	6·90	3·45	6·90	31·03	13·79
Cheltenham - - - - -	21·05	—	21·05	63·16	55·55
Chester - - - - -	—	—	—	—	—
Culham - - - - -	8·33	—	25·00	58·33	33·33
Durham - - - - -	16·66	—	—	66·66	—
Edinburgh (Ch. of Scotland) - - - - -	—	—	—	80·77	30·77
“ (Free Church) - - - - -	5·26	10·53	—	78·95	26·31
Exeter - - - - -	11·11	—	11·11	22·22	11·11
Glasgow (Ch. of Scotland) - - - - -	—	4·54	4·54	81·81	40·90
“ (Free Church) - - - - -	10·00	—	30·00	70·00	30·00
Hammersmith - - - - -	—	—	—	73·33	20·00
Homerton - - - - -	—	—	—	60·00	—
Peterborough - - - - -	9·52	—	—	33·33	19·04
Saltley - - - - -	14·63	2·44	12·19	24·39	39·02
Westminster - - - - -	32·35	8·82	8·82	76·47	23·53
Winchester - - - - -	29·41	—	5·88	35·29	29·41
York - - - - -	8·33	—	—	50·00	8·33
Average per-centage - - - - -	13·41	3·17	10·48	56·09	28·36



instruction into the education of pupil teachers, and the re-establishment of scientific instruction as a part of the curriculum of training colleges.

35. We do not consider that the evidence which we have received is exhaustive or conclusive as to the causes which have led to the results which we have stated; but whatever may have been their origin, we fear that an extension of the curriculum, so as to include elementary science, could not be expected to succeed until the means of scientific instruction for the students are more complete, and until the students enter in a better state of preparation, or remain a longer period.

36. On the other hand, the extension of the time of education in Training Colleges would obviously raise questions of expense both with respect to the buildings and annual outlay. These questions may bring under consideration the expediency of adopting, to a greater or less extent, the alternative of instruction without board.

37. Before we leave this part of the subject, we think it expedient to state that the encouragement of instruction in the rudiments of natural knowledge in elementary schools falls properly within the province of the Education Department, and should be adequately provided for in the regulations of the Code issued under its authority.

### Recommendations.

I. We recommend, as regards the elder children in the Elementary Schools, that the teaching of such rudiments of Physical Science as we have previously indicated should receive more substantial encouragement than is given in the Regulations of the New Code.

II. We recommend, as regards the younger children, that Her Majesty's Inspectors should be directed to satisfy themselves that such elementary lessons are given as would prepare these children for the more advanced instruction which will follow.

III. We recommend that the mode of instruction of Pupil Teachers; the conditions of admission to Training Colleges; the duration of the course of study in them; and the syllabus of subjects taught, should be so modified as to provide for the instruction of students in the elements of Physical Science.

## II.—SCIENTIFIC INSTRUCTION IN SCIENCE CLASSES UNDER THE SCIENCE AND ART DEPARTMENT.

### *Origin and growth of the System.*

38. Before the year 1859, elementary instruction in science was scarcely attainable by the working classes. Some of the principal mechanics' institutions of great towns had, from time to time, popular lectures on scientific subjects, which were frequently illustrated by experiments, diagrams, or specimens; but these lectures seldom extended to systematic courses. In very few of such institutions did any classes exist for collective instruction; scarcely any had laboratories; and whatever collections of natural objects existed were almost always ill-arranged and incomplete, even for the purposes of very limited instruction. Certain exceptions to this description existed, as, for instance, in Glasgow, Edinburgh, Manchester, Liverpool, and one or two institutions in London. But in smaller towns, and in manufacturing and rural districts, no such instruction was attainable except from one of the better educated schoolmasters, whose time, however, was otherwise sufficiently occupied.

39. The Department of Science and Art was constituted in 1853 by a Minute of the Treasury in consequence of the representations of the Board of Trade (under whose jurisdiction a Department of Practical Art was at that time included), and was placed under the Committee of Council on Education.

40. In 1859, the Department, thus constituted, originated a system of teaching by means of Elementary Science Classes and of payment on the results of the examination of the scholars. Examinations on a somewhat similar plan had been carried on by the Society of Arts, through local agency, in different parts of the kingdom; but, whilst encouragement was given to students by granting prizes for proficiency, the plan did not include any direct aid or encouragement to teachers. The object of the system introduced by the Science and Art Department was more comprehensive, for it proceeded to encourage the formation of a class of teachers of elementary science, and to stimulate and reward their activity by granting a payment, proportionate to attainments, for every pupil who passed an examination in one of certain successive stages of proficiency.

41. This system has given a remarkable impulse to elementary scientific teaching throughout the United Kingdom, some indication of which will be gathered from the



following table, showing the number of schools and persons under instruction in successive years :—

			Number of Schools.			Number under Instruction.
1860	-	-	9	-	-	500
1862	-	-	70	-	-	2,543
1864	-	-	91	-	-	4,666
1866	-	-	153	-	-	6,835
1867	-	-	212	-	-	10,230
1868	-	-	300	-	-	15,010
1869	-	-	523	-	-	24,865
1870	-	-	799	-	-	34,283

### *Teachers.*

42. As the introduction of the system coincided with the period in which the masters of elementary schools were under great apprehension as to the reduction of their emoluments, and did often actually suffer considerable loss, they naturally availed themselves of the opportunity offered by a Department of the Government to increase their income by teaching science classes in the evening. This course was open to them if, either by their own unaided personal exertions and private studies, or by attendance on elementary science classes, they could acquire sufficient knowledge to enable them to pass whatever examination was required.

43. A special examination was originally instituted for teachers, and a certificate was issued recognising the amount of knowledge which they had obtained. But, subsequently, the Department relied to such an extent upon the examination of the papers of the pupils in the several classes as to regard the special examination of the teachers as, "to a great extent, unnecessary." Any student of an elementary science class recognised by the Department, if he pass in the advanced classes of the annual May examination, is now deemed to be qualified to teach, and may, by presenting pupils at a subsequent examination, earn by their success the grants given by the Department.

44. Under these conditions an elementary schoolmaster could, with the consent of his school committee, open his schoolroom in the evening for the instruction of the youth and adults of the working classes in his vicinity. Many scholars in his own more advanced classes passed from the elementary school at once into the evening school, and he gathered about him others who had been his pupils in previous years. The knowledge of the existence of such a class spread to others whose education had been neglected; and some who were desirous to fit themselves for positions in manufactures or trade requiring some elementary scientific knowledge, resorted to these classes as a first step towards the attainment of that object.

45. The number of teachers in March 1871 was 957. From a return made at a somewhat earlier period to a circular issued by the Science and Art Department at the suggestion of this Commission,\* it appears that, of the 867 qualified science teachers employed at the date of the return, 556 were day-school teachers. Of these, 429 were certified as elementary school teachers by the Education Department in Whitehall or in Dublin, and 112 possessed no such certificates. One large section of the masters of day-schools who conduct science classes in Great Britain has passed through the Training Colleges, and, up to 1861, as we have already observed, had in many of those colleges an opportunity of obtaining an elementary knowledge of one or two branches of science. Such masters have had experience in teaching, and possess considerable knowledge of the organisation, discipline, and methods of instruction adopted in elementary schools. The masters who have left the Training Colleges since 1863 have passed through a more limited course of study, but they have recently been stimulated to acquire some knowledge of science in the elementary classes under the Science and Art Department.

46. We feel that the experience and skill of even an uncertificated teacher, and the previous literary training of certificated teachers, qualify them to acquire an elementary knowledge in the existing elementary science classes with a greater degree of success than inexperienced students. When they take charge of science classes, the skill they have acquired in giving instruction cannot fail to increase their success as teachers, especially in promoting the development of the intelligence of the pupils.

\* See Appendix XII., p. 71.



47. There remain, according to this return, 311 private teachers, who are not day school teachers, of whom 259 are persons having other employments in the daytime. The occupations are commonly those of tradesmen's clerks, surveyors' assistants, draughtsmen, mechanics, or handicraftsmen, or persons employed in such trades as dyeing or calico printing. In these last, the work affords some opportunities for acquiring skill in chemical manipulation. It is probable that, notwithstanding the want of training in the management of classes, and in teaching, and the occasional want of literary qualifications, many of these teachers have rendered valuable service. We are also informed that 79 hold honorary science certificates; that 33 of them obtained certificates according to the method of examination in use previously to 1867; and 176 have qualified according to the system now in use by passing in the advanced classes at the May examinations, while 23 hold the certificates awarded in consequence of the examination previously to 1867 in some subjects, and have qualified in other subjects at the present May examinations by passing the advanced classes. We have no information as to what is the relative scientific knowledge of the several classes of teachers.

48. The steadily increasing stringency of the examination, ensured both by the character of the questions and the requirements of the examiners as to the answers, has doubtless had considerable influence on the qualifications of the teachers. The operation of the system has been marked by a progressive improvement in the answers to the examination papers.

49. While the increased stringency of the examinations to which we have already referred supplies a powerful motive to the teachers to improve themselves, an important opportunity of such improvement is afforded by the system recently introduced by the Department of supplying courses of lectures in the metropolis, with opportunities of practical instruction, which science teachers are aided in attending by a grant towards their expenses. The initiation of this system is thus described :

"In accordance with the terms of the Minute of 11th March 1869, two courses of six lectures each to science teachers were delivered: one of them, on Light, by Professor Guthrie, was given at the Royal School of Mines, Jermyn Street, on the evenings of the week ending the 3rd July; the other, on Animal Physiology, by Dr. Michael Foster, prefaced with an introduction by Professor Huxley, in the Lecture Theatre of the South Kensington Museum, during the following week.

"These lectures were specially meant to instruct teachers in the art of teaching, making their experiments, &c.; and special pecuniary assistance was given to enable teachers generally to avail themselves of the opportunity, which 253 did. Of these 169 attended both courses, 35 that on Light only, and 49 that on Physiology only. The total numbers attending the two courses were, therefore—Light, 204; Physiology, 218. Admission to the lectures was also given to various other persons connected with education, including several Principals and Tutors of Training Colleges who made application for it.

"Simultaneously with the delivery of these lectures a short course of practical instruction in the laboratory of the Royal College of Chemistry was given by Dr. Frankland and Mr. Valentin, permission to avail themselves of which was given to 153 teachers."

50. In 1870 short courses of lectures, of a similar character, upon chemistry and experimental physics were delivered by Dr. Frankland and Professor Guthrie, and were accompanied by six days' work in the chemical laboratory for each teacher who came up for instruction.

51. In the year 1871, the Lords of the Committee of Council on Education, "finding that the special courses of lectures on teaching science have been very successful, and highly appreciated by the masters for whose benefit they were instituted," provided for an extension of this kind of instruction in biology and in experimental physics.

52. The course on Biology was commenced by Professor Huxley on the 14th of June; and the course on Experimental Physics by Professor Guthrie on the 5th of July. Each course lasted six weeks, and was attended by between forty and fifty persons.

53. Oral instruction was given by the Professors in the form of lectures or otherwise; but the most important feature of the course was the practical work through which every one under instruction was made to pass, and which occupied four or five hours of each working day.

54. In giving this practical instruction, each Professor was aided by several highly competent Demonstrators.

55. We are of opinion that the arrangements for the instruction of teachers, thus briefly described, have already been of material benefit, though, as yet, they have been attended by no great number of teachers; and that they may be continued and extended with every prospect of advantage.



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### *Buildings and Apparatus for Teaching.*

56. Excepting when building grants are given, no restriction is placed upon the character of the room or building in which the class may be held. To quote the words of Mr. Cole, "it might be held in a garret or in a cellar." Neither is it required that a typical collection of specimens, apparatus for the illustration of instruction, or for acquiring skill in the use of instruments, or a laboratory for practice in manipulation, should be attached to an elementary science class. Such requirements would obviously, at the origin of the system, have proved insurmountable hindrances to the formation of these classes in the great majority of instances.

57. Science classes conducted by certificated and uncertificated day-school teachers are commonly held in day schoolrooms, which are generally sufficiently commodious, and are frequently furnished with well-arranged desks and benches, with black-boards, and easels, and the other ordinary apparatus of elementary instruction.

### *Subjects Taught.*

58. The subjects taught are as follows :

Subject	1. Practical Plane and Solid Geometry.
	2. Machine Construction and Drawing.
	3. Building Construction.
	4. Naval Architecture and Drawing.
	5. Pure Mathematics.
	6. Theoretical Mechanics.
	7. Applied Mechanics.
	8. Acoustics, Light, and Heat.
	9. Magnetism and Electricity.
	10. Inorganic Chemistry.
	11. Organic Chemistry.
	12. Geology.

Subject	13. Mineralogy.
	14. Animal Physiology.
	15. Zoology.
	16. Vegetable Anatomy and Physiology.
	17. Systematic and Economic Botany.
	18. Principles of Mining.
	19. Metallurgy.
	20. Navigation.
	21. Nautical Astronomy.
	22. Steam.
	23. Physical Geography.

59. The teachers in the several schools are aided in their course of instruction by a Syllabus carefully prepared by the eminent scientific men who act as examiners, setting forth the range of study required, so as to enable the pupils to prepare for examination.

60. The syllabus is, in fact, a valuable outline of a course of elementary scientific instruction, suitable to the working classes. It is the result of the experience of men who have devoted themselves for many years to the teaching of science.

### *Examinations.*

61. From the memorandum printed in our Appendix III. (p. 6.), with regard to the preparation of the papers for the science examinations of May 1870, it appears that there are three papers in each subject: A., an elementary or first stage paper; B., an advanced or second stage paper; and C., an honours paper. The examiners frame their papers with a view to discourage and detect mere cramming.

62. The examination is conducted under the superintendence of local committees.

63. All students in the science classes are required to present themselves for examination in the elementary stage before they come up in the second or advanced stage. The elementary paper is intended to meet what may be expected to be the reasonable results of one or two years' instruction of lads of from 13 to 14, and artizans who attend classes during the winter evenings. The paper, however, covers a wide range, so as not only to reward the teachers who, by careful instruction of the duller pupils, enable them to pass in the lowest class, but, likewise, in the case of the better informed and more intelligent pupils, to secure the higher grants to the teacher where they pass in the first class.

The advanced paper is intended to test what may be regarded as a reasonable amount of progress in knowledge after another year's instruction.

The honours paper requires for success more efficient means of instruction than are commonly afforded by the elementary science classes, and is adapted to the acquirements of highly advanced students, teachers, and candidates for the Whitworth and other scholarships.

64. The examination papers are privately printed, and are distributed by post in sealed packets addressed to the proper officers of the several committees of elementary science schools throughout the country.

65. On the evening of an appointed day, the seal of this packet is broken in the presence of at least three members of the committee, and the papers are distributed to the several candidates assembled. The papers are worked in the presence of three selected members of the committee, in order to prevent any assistance being given to any student. The examination, excepting in two subjects, lasts three hours—from 7 till 10. The written answers are collected, sealed in the presence of the Committee, and returned by post to the office of the Department. The duties of the committee may



extend over eight or ten successive evenings, when several separate subjects have been taught. The mode of appointment of the committees from which these members are selected, is obviously important as a means of preventing any breach of rules in the conduct of the examination. The regulations of the Department, as to the constitution of the committees, are carefully drawn, and, if carried out in the letter and in the spirit, would ensure an occasional visitation of the classes while under instruction, and would effectually prevent any unfair proceedings at the examinations.

66. The Department acknowledges the attention of the Local Committees at the period of examination. "It is through their agency that more than 2,000 examinations were held in all parts of the country in 1869. Mistakes and irregularities have in some cases occurred, as might be expected, from the novel nature of the duties to some gentlemen." The employment of 60 or 70 officers of the Corps of Royal Engineers as Local Inspectors has, as in the previous year, been of great service in assisting the Local Committees, and seeing that the rules were strictly adhered to. In this way about 500 of the examinations were visited.\* "By these means several cases of irregularity were" (as Mr. Iselin reports) "brought to the knowledge of the Department."

67. Mr. Iselin remarks that "a periodical inspection of the science schools and classes has always been found useful in preventing the spread of irregularities, and in controlling the appointment and action of the Local Committees, over whom, otherwise, the Department, from want of special local knowledge, could exercise no authority."†

68. We are informed that the Department has had under its consideration the question whether School Boards established under the Education Act, 1870, might not be of service in the appointment of Committees, and in the selection of the members to be present at the examinations, as well as by the attendance of their own officers.

69. The same scientific men who prepare the syllabus of studies and the examination papers, are likewise charged with the duty of reporting on the results. They nominate, for appointment by the Department, assistant examiners, and their suggestions in this respect are in practice adopted. As in eight of the subjects above 2,000 papers have to pass under their scrutiny, these papers are divided by the chief examiner among his assistants. As the papers are distinguished only by numbers, the examiners have no knowledge of the classes or schools from which the papers come. The assistants receive instructions from the chief examiners as to the mode of conducting their work, so as to secure uniformity. Certain of the papers are taken as examples, and the amount of marks to be allotted is determined in a preliminary conference between the chief examiner and his assistants. When each assistant has completed his work, it is reviewed in all special cases by the examiner. The honours papers are read, and the marks for these are awarded by the chief examiner himself.

70. Out of 29,928 elementary and advanced stage papers examined in 1870 (*Eighteenth Report of the Department*, 1871, p. 57.), 25,200 were presented in the elementary stage, and of these 11,835 failed. Of 4,728 papers examined for the advanced stage, 1,723 failed. The per-centage of failures in the elementary stage was 46·96, and in the advanced stage, 36·44. The proportion in successive years is indicated in the following table, extracted from the 17th and 18th Reports of the Science and Art Department for 1870, 1871 (p. viii. in both).

—	Number of individual Candidates who presented themselves for Examination.	No. of Papers worked.	No. of Papers passed.	Prizes.
1867	4,520	8,213	6,013	3,453
1868	7,092	13,112	8,649	5,246
1869	13,234	24,085	14,550	1,969
1870	16,515	34,413	18,690	3,108

71. The prizes consist of four medals (one gold, one silver, and two bronze); Queen's prizes (books or instruments); scholarships of 5*l.* (to assist in the instruction of deserving students); local exhibitions—grants of 25*l.* per annum for one, two, or three years, where the locality raises a like sum by voluntary subscriptions (to enable students to complete their education at some college or school where scientific instruction of an advanced character may be obtained); and Royal exhibitions (tenable for three years) to the Royal School of Mines, London, and the Royal College of Science, Dublin. Free admissions to the last-named institutions are also given to all gold medallists.

72. A table communicated by Captain Donnelly gives the ages of 34,336 students examined in 1870, and the number who passed at each age.

\* *Seventeenth Report of the Department* (1870), p. x.

† *Seventeenth Report of the Department* (1870), p. 53.



73. Of those examined 4,739 were under 13, the age to which day-school attendance is required under the Factory Acts, and 7,746 were under 14, the age to which efforts have been made to extend the operation of those Acts.

74. Among these 7,746, there were 5,027 unsuccessful candidates. In considering this proportion due allowance must be made for age, but it would probably be improper to regard this result as a measure of the capacity for scientific instruction of boys up to this age. It must be taken into account that, for the most part, the scientific instruction received by the teachers themselves was elementary, their training imperfect, and that their classes were conducted without the aid of experimental or other illustrations.

75. An inspection of the table will show that the per-centage of success increases in each year up to candidates who were 20 years old, when it was 62·5, having been 62·3 in the preceding year. Between 12 and 13, one-third of the candidates were successful, and a somewhat greater proportion between 13 and 14:

AGES of CANDIDATES who presented themselves for Examination, May 1870.

Ages.	Number of Papers handed in by Candidates of the respective Ages.	Number successful.	Per-centage of Successes in Nos. examined.
60	2	—	—
59	—	—	—
58	2	1	50·
57	—	—	—
56	—	—	—
55	4	—	—
54	4	3	75·
53	6	2	33·3
52	5	1	20·
51	5	2	40·
50	12	7	58·2
49	13	9	69·3
48	6	3	50·
47	21	12	57·1
46	18	13	72·2
45	30	14	46·6
44	31	15	48·3
43	33	19	57·5
42	48	26	54·1
41	34	20	58·8
40	58	31	53·4
39	63	41	65·07
38	86	39	45·3
37	93	49	52·6
36	128	61	47·6
35	127	75	59·0
34	172	93	54·0
33	157	84	53·5
32	209	127	60·7
31	268	148	55·2
30	393	218	55·4
29	350	203	58·
28	425	262	61·6
27	400	234	58·5
26	512	305	59·5
25	738	438	59·3
24	832	479	57·5
23	1,016	579	56·9
22	1,104	660	59·7
21	1,476	909	61·5
20	2,103	1,315	62·5
19	2,682	1,672	62·3
18	2,684	1,530	57·
17	2,270	1,175	51·7
16	2,440	1,251	51·2
15	2,654	1,277	48·1
14	2,876	1,274	44·2
13	3,007	1,164	38·7
12	2,572	890	34·6
11	1,397	451	30·9
10	599	175	29·2
9	142	34	23·9
8	29	5	17·2
Total	34,336*	17,395	50·6

\* The discrepancy between this and the number given in p. 19 arises from an occasional double counting of papers, which cannot be detected at the time.



76. We have had before us certain of the Examiners: from them we have derived the impression already recorded, that substantial advantages result from the system of instruction pursued, but from the considerable proportion of failures which occur, as well as from the character of the answers given, the examiners are under the impression that a very large part of the instruction is derived from books, tested and aided by the class examinations of the teachers; and that it is not often illustrated by specimens or experiments, the use of apparatus, or the out-door study of nature. One of the examiners even complains that it is clear that the common expedient of the black-board and chalk is not used to illustrate instruction in geology. We have it in evidence that not only is scientific apparatus wanting, but that too often the teachers confine their instruction to the same routine of book learning and class questioning with which alone they were made familiar in the rudimentary classes in which they received their own imperfect elementary knowledge.

77. The examiners conclude that when there is a great preponderance of failures in any school, the teacher has systematically endeavoured to prepare his students by an almost exclusive exercise of the memory. Mr. Iselin confirms this impression by reporting that "this defect is most observable in science classes established in connexion with, and for the pupils of elementary schools, where the students are more immediately under the control of the teacher. In order to produce good results, the youth, and often the deficiency in primary education of his pupils, compels the teacher to cultivate their memory rather than their intelligence."\* Teachers of elementary day schools are, as we have already observed, under strong inducements to found evening science classes, and the transfer of scholars immediately from the day to the evening schools is one chief means of filling those classes.

#### *Inspection.*

78. There are only two permanent Inspectors of Local Schools of Science and Art, and as their inspection extends to the Art as well as to the Science Classes, it is obvious that their supervision must be inadequate to provide any important check against irregularities, or to greatly influence the methods and means of instruction.

79. The Engineer Officers before referred to are employed as local inspectors, their only duty being to see that the regulations of the Department are complied with. They are not charged to report upon the methods of instruction adopted by the teachers, as to the degree in which that instruction is limited to text-books, and to class examinations, founded upon such book instruction, nor as to the comparative skill and knowledge of method, or assistance from apparatus or specimens, by which the success of the teaching may be promoted. But a system of inspection embracing these objects, yet without proceeding to systematic individual or class examination, would be of great value as a supplement to the May examination of the papers of the pupils.

80. Practical instruction in the science classes would be greatly promoted by more frequent inspection, followed by reports on the methods and apparatus employed, and the number of pupils receiving such practical instruction.

#### *Payments on Results.*

81. Payments are made by the Department on account of each successful student of the industrial classes,† at the rate of 1*l.* for every second class, in either the elementary or the advanced stage; of 2*l.* for a first class in either of these stages, or for

\* *Seventeenth Report of the Science and Art Department* (1870), p. 57.

† The following definition of these classes is thus given in the 24th edition of *The Directory of the Science and Art Department*:

"Under 'Students of the Industrial Classes' are included:—

- a. Artisans or operatives in the receipt of weekly wages.
- b. Coastguards, policemen, and others who, though in receipt of weekly wages, do not support themselves by manual labour.
- c. Teachers of elementary schools in connexion with the Education Department, Whitehall, or the National Board of Education, Ireland. (See exceptions in § XLVII., p. 17, and in the special rules applying to Irish National School Teachers, see p. 32.)
- d. Persons in the receipt of salaries not large enough to render them liable to the income tax, as some descriptions of clerks, shopmen, &c.
- e. Small shopkeepers employing no one but members of their own family and not assessed to the income tax.
- f. Tradesmen and manufacturers on their own account, supporting themselves by their own manual labour, not employing apprentices, journeymen, &c., and not assessed to the income tax.
- g. The children (not gaining their own livelihood) of all such persons above mentioned.

No payments are made on account of any other students."



a second class in honours; and of 4*l.* for a first class in honours. "The payments to teachers on the results of the instruction of the artisan classes, as tested by these examinations, amounted in the year 1869, to 17,015*l.* 15*s.*, being at the rate of about 13*s.* 7*d.* for each person under instruction. In the previous year the rate paid was about 17*s.* 5*d.*."\* In this way teachers were sometimes enabled to earn considerable sums, and in the 17th Report, 1870, the average payment to the teachers is stated to be 35*l.* a year, while one earned as much as 227*l.* 10*s.*, and the Bristol Trade School, with three teachers, earned, in 1869, 653*l.* Although we do not think that either the times of attendance, or the amount and sources of contributions in elementary schools can be strictly compared with those in science classes, it may be worthy of observation that the elementary schools are required to be open 400 times, and no grant is made for the elementary instruction of any boy or girl who has not attended 250 morning or afternoon meetings of the school, whereas the science classes are only required to be open 25 times in the year. The cost per head of teaching each scholar in an elementary school, calculated on the average attendance, ranges from 21*s.* to 30*s.*; but the average rate of grant was reduced by the operation of the Revised Code from 12*s.* 3*d.* to 8*s.* 6*d.* or 9*s.* per scholar, and the maximum grant attainable under the New Code cannot exceed 15*s.*, nor can it exceed one half the sum raised by fees and subscriptions.

82. The expenses are defrayed by school pence and contributions. We have grave doubts whether equivalent subscriptions could, at an early period, have been raised in support of the most improved forms of teaching in the elementary science classes. Nevertheless, we think it worthy of the consideration of the Department whether means could not be adopted to increase the resources of the elementary science classes by greater payments from the pupils, and by local contributions. This will become necessary in proportion as practical instruction is introduced. Though, in the earliest period, to have required local contributions, bearing some proportion to the grants, might have prevented the establishment of the classes, that danger ought, if the instruction is valued, gradually to cease to exist.

#### *General Remarks.*

83. The efficiency of the instruction given in the science classes has been diminished, on the one hand, by the imperfect organization of the classes, whether considered separately or in groups, and the absence of practical teaching; and, on the other, by the irregular and unsystematic manner in which scholars have taken up the subjects taught.

84. As an example of the efficiency of scientific instruction as an instrument in the education of boys belonging to the humbler middle classes, and from 12 to 15 years of age, we think it desirable to describe the Bristol Trade School, which was successfully developed under the guidance of the late Canon Moseley, who, both as a Professor at King's College, London, and, subsequently, as an Inspector of Training Colleges, had prolonged experience of such instruction.

Qu. 6338. 85. This school was designed for boys intended for "trades chiefly connected with the construction of machinery and building," or for general commercial pursuits.

Qu. 6338. 86. The school now contains 160 boys, who belong chiefly "to the manufacturing and mechanical trades." It comprises an elementary department of 100 boys, from 10 to 12 years old, who learn "nothing of science" "except a little practical geometry."

Qu. 6346. These elementary classes are introductory to the science department, which is attended by 60 boys, who "pass from the elementary part of the school into the science part at about 12, and remain until the age of 15." "There are four masters" to the whole

Qu. 6353. school, "each of whom takes his share in the general literary work." "There is only one master who is not engaged in both divisions." "One master devotes himself more especially to mathematics, another to descriptive geometry and its application to machinery and building structures, and to applied mechanics;" and the head master "to chemistry and experimental physics."

Qu. 6329. 87. The head master (Mr. Thomas Coomber) gives the following account of the instruction in the Upper Department: "We teach mathematics and the application of mathematics to mechanics and mechanism, descriptive geometry, and the applications of descriptive geometry to machine drawing and building construction." "In addition

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\* *Seventeenth and Eighteenth Reports of the Science and Art Department of the Committee of Council on Education* (1870 and 1871), p. viii. in both.



"to that, we teach chemistry, both inorganic and organic, and experimental physics, which includes electricity, magnetism, light, and heat." Nothing systematic has yet been effected in the day school in the practical scientific instruction of boys in the laboratory. This, "as far as the day school is concerned," is confined "to several boys who have been withdrawn from the school, and have become apprentices as chemists." A mining school is connected with the trade school, and contains six pupils, who have the advantage of attending the scientific classes. A fifth master superintends this school. Considerable opportunities are afforded for practical observation, and for manipulation in the laboratory, in connection with the mining school. "The boys who are educated" in the day school, "and leave at ages varying from 14 to 15, continue their education, after their day's work, in the evening school." Free exhibitions to the lectures of the Royal School of Mines in Jermyn Street have been awarded to three of the scholars, to enable them to pursue the scientific study of mining. One of the former mining scholars is "the manager of a colliery in South Wales; another is now engaged in the development of a coalfield at Natal; and the third used the education which he acquired at the Royal School of Mines in London to obtain a science scholarship at Cambridge, and is still at Cambridge." The boys educated in the trade school "are, as a rule, doing very well indeed;" but so short a time has elapsed since the commencement of the school that instances of remarkable success can scarcely yet be expected.

Qu. 6334-6.

Qu. 6353.

Qu. 6339.

Qu. 6342.

Qu. 6343.

Qu. 6349.

88. The charges and resources of the school are thus described: "Our fee is 3*l.* per year in the trade school, and in the mining school an additional 7*l.*, in all 10*l.* [in the mining school], so that our income for the past year will be very nearly 450*l.* from fees in the trade school only." This is increased by subscriptions, and by the rent of the cellar, to a little more than 500*l.* a year, independently of the grants of the Science and Art Department. Out of the grants to science classes in this school in 1871 240*l.* 15*s.* were for the day school.

Qu. 6355.

Qu. 6356.

89. As an example of the grouping of classes for the purpose of introducing the services of more efficient teachers, we proceed to give a brief sketch of the organization of a group of evening classes formed in East Lancashire. These classes were in the first instance assembled for the purposes of elementary literary instruction, either in day school-rooms or in the rooms of literary and mechanics' institutions. They were conducted at one period by three kinds of teachers. Besides the principal teacher, one of the most successful students of former years was appointed a local assistant teacher. These local teachers were for a time encouraged by a grant of 10*l.* annually from the Committee of Council on Education. They were aided by a pupil fulfilling the function in the evening school which a pupil teacher does in the day school. Such teachers were paid 5*l.* annually from a local subscription. We may remark, incidentally, that the training of such assistants in elementary science schools would greatly facilitate the introduction of practical instruction by the aid which they would give to the master in all mechanical details; while, on the other hand, such assistance would insensibly, but surely, impart such skill and knowledge as would give an impulse to the career of the pupil so employed.

90. The class, organized as we have described, was visited on one or two evenings in the week by a highly-instructed certificated master, qualified also to give elementary instruction in science under the Science and Art Department. A class in the ordinary rudiments of literary instruction, and another in the elements of science, were conducted by him at successive periods of the same evening, and the youths who had entered in the literary class, commonly, after having passed through that, proceeded to receive instruction in the science class, and became candidates in the science examination. By these expedients the services of a master of much greater experience, skill, and knowledge, were obtained for the entire group of science classes. Boxes of apparatus were provided by subscription aided by the grants of the Education Department, or the Science and Art Department, and the instruction by these means assumed a more practical form. The master of this group of schools gave, in the daytime, scientific instruction in a grammar school, and, on Saturdays, to a class for elementary day-school teachers, as well as in a private school. Efforts have been made to introduce a similar system into a few other districts.

91. As a remedy for the irregular and unsystematic manner in which students take up subjects for the study of which they are unprepared, the Science and Art Department on



the 24th November 1871, issued a Minute\* suggesting the adoption of definitely arranged courses of instruction, and offering encouragement in the form of extra payments to the schools in which such courses are adopted. This minute will be of especial service to the teachers themselves, who have hitherto been in the habit of qualifying themselves successively in different subjects without sufficient regard to their connection.

92. In the preceding outline of the system of elementary scientific instruction which has rapidly sprung into existence under the Science and Art Department, we have recognised the high value of the schemes of instruction prepared for each branch of study by the examiners, as well as the skill and care with which they have superintended the examination of the papers by which the distribution of the grants has been determined, and have been enabled year by year to raise the standard of instruction. On the other hand, we have not concealed the imperfections, either of the organization or the working of this system, or of its results.

93. These imperfections seem to have been the unavoidable incidents of the mode in which these classes came into existence, and of their very rapid extension, notwithstanding many difficulties and obstacles. The undeveloped state of elementary education, and the defects of the only machinery available for the establishment of these classes, rendered necessary the experiment of employing whatever rooms and teachers were at hand. The degree of success attained in the enterprise of thus boldly opening, in spite of all obstacles, a path for the introduction of a system of elementary scientific instruction, is greatly due to the vigorous and able administration of the Department, and to the efficiency with which the examinations have been conducted.

94. The ground thus prepared may hereafter be occupied, step by step, with elementary science schools in well-constructed buildings, supplied with proper apparatus, and a sufficient staff of trained teachers. These schools may train assistant teachers, may group around them humbler classes, and aid them with apparatus and superintendence or instruction.

95. The first steps have been taken with such vigour, and the result has been to such an extent successful, that we confidently expect that, with needful guidance and encouragement, a thoroughly efficient system of elementary scientific instruction for the working classes may, ere long, be founded on this basis. Our recommendations show in what way, in our judgment, the existing system should be further developed.

### Recommendations.

IV. We recommend that the instruction in elementary science classes under the Science and Art Department, be so arranged as to work in complete harmony with the general system of public elementary education, but, at the same time, we consider it important that the Education Department and the Department charged with Instruction in Science shall continue to be co-ordinate.

V. We recommend that a more efficient inspection of Elementary Science Classes be organized, and that the Inspectors should advise the Local Committees and report on :—

- (a.) The apparatus of instruction.
- (b.) The state of the discipline and methods.
- (c.) The general efficiency of the arrangements.

VI. We recommend that teachers who have already qualified by passing the May examination in either of the advanced classes shall continue to be recognised as qualified to conduct Elementary Science Classes, with the title of *Elementary Science-Teacher*, and to earn the grants awarded by the Department of Science and Art on the results of the examination of their scholars; but that this qualification and title shall in future only be attainable by passing in the first of the advanced classes.

VII. We recommend that should such arrangements as are herein-after set forth for conducting the practical instruction of teachers, and for providing for them practical examination at several centres, be adopted, all elementary science teachers shall, after such practical instruction, be admissible to a further examination, which, in all suitable subjects, shall be practical. We recommend that success in this examination shall entitle a teacher to a certificate of *Second Grade Science Master*.

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\* See Appendix XIX., p. 57.



VIII. We recommend that, as an inducement to teachers to prepare for and pass this further examination, payment for results in the case of a Second Grade Science Master be made at a somewhat higher rate than in that of the Elementary Science Teacher.

IX. We recommend that an examination, both by papers and by practical tests, in any group of allied subjects defined by the Department which the candidate may select, shall be open to all those teachers who have passed in the advanced classes, or who have been otherwise admitted as Science Teachers; and that success in this examination shall entitle the candidate to receive a certificate of *First Grade Science Master* in that group.

X. We recommend that a greater capitation grant be payable in respect of the scholars of a First Grade Science Master teaching in any group of allied subjects with or without assistance, than in respect of the scholars of a Second Grade Science Master, provided that the Inspector report that the apparatus is sufficient, and that practical instruction has been given in each suitable subject.

XI. We recommend that, with a view of maintaining uniformity of standard in these examinations, they shall be conducted at the several local centres by the staff of Examiners acting under the Science and Art Department.

XII. We recommend that the more systematic training of the teachers of science referred to, be provided for—

- (a.) By the adoption of special arrangements for this purpose in the Science School which has been referred to in our First Report; and by the recognition by the Department of similar arrangements for the instruction of this class of students in any University or College, and in Science Schools as herein-after described.
- (b.) By giving to the students of Training Colleges the opportunity of remaining a third year, during which scientific instruction may either form a principal part of the curriculum of such Colleges or be accessible in some adjacent College or School of Science approved as efficient for that purpose.

XIII. We recommend that the Science and Art Department be at liberty to dispense with the preceding examinations and to accord the privilege of First and Second Grade Science Masters in consideration of University Examinations in Science, or of a satisfactory course of study in Colleges in which Science is taught, as well as in other cases of obvious scientific qualification.

XIV. We recommend that in schools recognised as Science Schools, as herein-after set forth, facilities for the employment of Assistant Teachers be afforded as an experiment on a limited scale, some addition being made to the emoluments of the teacher in consideration of the instruction afforded; provided the Department be satisfied, on the report of an Inspector, that such assistant teacher has received practical instruction in subjects in which it is prescribed, and that he has been actively engaged in teaching.

To encourage the more advanced scholars to become assistant teachers under first grade masters in such schools, a small stipend, rising in successive years, might be granted on condition that a like sum was raised locally, subject to such conditions as the Department might deem expedient. The proportion of assistant teachers should not exceed one for every 15 successful scholars in any science school, and no scholar should be recognised as an assistant teacher until he has passed in the first division of the elementary class in the May examination.

XV. We recommend that, with a view of training First Grade Science Teachers, exhibitions of sufficient value and in sufficient numbers be offered to elementary science teachers and to assistant teachers who have served three years, and passed in the first division of the advanced class in the May examinations; and that such exhibition should be tenable in any University, College, or Science School recognised in Recommendation XII.

XVI. We recommend that the grants made by the Science and Art Department for buildings be extended, under sufficient guarantees, so as to embrace institutions for scientific instruction, although they may not be built under the Public Libraries Act, or be in connexion with a School of Art.

XVII. We recommend that grants similar to those now made for apparatus be given for laboratory and museum fittings under proper guarantees.



XVIII. We recommend that whenever the arrangements for scientific teaching in any institution shall have attained a considerable degree of completeness and efficiency, such institution be recognized as a Science School, and be so organized as to become the centre of a group of elementary science classes; and to provide the assistance of First Grade Science Masters, the loan of apparatus and specimens, and the means of instruction in the laboratories and museums to the more advanced students of the group.

XIX. We recommend that assistance be given for the formation and maintenance of such Science Schools by special grants, the conditions of which shall be determined by regulations to be framed by the Science and Art Department.

XX. We recommend that when laboratories are attached to second grade grammar schools in the schemes issued by the Endowed Schools' Commissioners, the Trustees of such schools be encouraged and enabled to invite the formation of elementary science classes, to be taught therein.

All of which we humbly beg leave to submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE.  
LANSDOWNE.  
JOHN LUBBOCK.  
J. P. KAY-SHUTTLEWORTH.  
BERNHARD SAMUELSON.  
W. SHARPEY.  
G. G. STOKES.  
HENRY J. S. SMITH.  
\* T. H. HUXLEY.

\* The Chairman has been authorized by Professor Huxley to affix his signature to this Report.

J. NORMAN LOCKYER,  
Secretary.

March 22nd, 1872.

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# LIST OF WITNESSES.

	Questions.	Pages.
<i>Tuesday, 14th June 1870.</i>		
Henry Cole, Esq., C.B. - - - - -	1-250	1-18
<i>Wednesday, 15th June 1870.</i>		
Thomas Henry Huxley, Esq., LL.D., F.R.S. - - -	251-358	19-26
Trenham Reeks, Esq. - - - - -	359-566	26-33
<i>Friday, 17th June 1870.</i>		
Andrew Crombie Ramsay, Esq., LL.D., F.R.S. - - -	567-757	34-44
Edward Frankland, Esq., D.C.L., Ph.D., F.R.S. - - -	758-835	44-53
<i>Tuesday, 21st June 1870.</i>		
The Rev. Joseph Woolley, LL.D. - - - - -	836-1020	53-60
C. W. Merrifield, Esq., F.R.S. - - - - -	1021-1168	60-66
<i>Friday, 24th June 1870.</i>		
Dr. Alexander William Williamson, F.R.S. - - -	1169-1402	66-84
<i>Tuesday, 28th June 1870.</i>		
Professor Joseph Henry - - - - -	1403-1575	84-92
Professor Fleeming Jenkin, F.R.S. - - - - -	1575-1787	92-105
<i>Friday, 1st July 1870.</i>		
William Richardson, Esq. - - - - -	1788-1936	106-114
Mr. Robert Applegarth - - - - -	1937-2046	114-124
C. Spence Bate, Esq., F.R.S. - - - - -	2047-2135	124-128
<i>Tuesday, 5th July 1870.</i>		
Mr. Thomas William Shore - - - - -	2136-2287	129-140
Warington W. Smyth, Esq., M.A., F.R.S. - - - - -	2288-2467	140-151
<i>Friday, 8th July 1870.</i>		
Sir Roderick I. Murchison, Bart., K.C.B., F.R.S. - - -	2468-2493	151-153
Lionel Brough, Esq. - - - - -	2494-2651	153-160
Sir William Thomson, LL.D., F.R.S. - - - - -	2652-2873	160-171
<i>Tuesday, 12th July 1870.</i>		
Henry Wentworth Acland, Esq., M.D., F.R.S. - - -	2874-2977	171-186
Robert Bellamy Clifton, Esq., M.A., F.R.S. - - -	2978-3099	186-194
<i>Friday, 15th July 1870.</i>		
John Phillips, Esq., M.A., F.R.S. - - - - -	3100-3209	194-205
George Rolleston, Esq., M.D., F.R.S. - - - - -	3210-3267	205-211
<i>Thursday, 21st July 1870.</i>		
The Rev. Bartholomew Price, M.A., F.R.S. - - -	3268-3462	211-220
Henry John Stephen Smith, Esq., M.A., F.R.S. - - -	3463-3573	220-226
<i>Friday, 22d July 1870.</i>		
Sir Benjamin Collins Brodie, Bart., M.A., F.R.S. - - -	3574-3690	226-235
George Rolleston, Esq., M.D., F.R.S. - - - - -	3691-3750	235-239
<i>Tuesday, 15th November 1870.</i>		
Rev. Mark Pattison, B.D. - - - - -	3751-3888	240-250
<i>Wednesday, 16th November 1870.</i>		
The Rev. Benjamin Jowett, M.A. - - - - -	3889-3979	250-256
<i>Tuesday, 22d November 1870.</i>		
The Rev. John Prideaux Lightfoot, D.D. - - -	3980-4089	257-265
Nevil S. Maskelyne, Esq., M.A., F.R.S. - - -	4090-4143	265-270



	Questions.	Pages.
<i>Wednesday, 23d November 1870.</i>		
The Very Rev. Henry George Liddell, D.D. - - -	4144-4226	270-274
<i>Tuesday, 29th November 1870.</i>		
The Rev. James Challis, M.A., F.R.S. - - -	4227-4303	274-279
J. C. Adams, Esq., M.A., LL.D., F.R.S. - - -	4304-4355	279-281
<i>Wednesday, 30th November 1870.</i>		
George Murray Humphry, Esq., M.D., F.R.S. - - -	4356-4526	282-292
George Downing Liveing, Esq., M.A. - - -	4527-4653	292-297
<i>Tuesday, 6th December 1870.</i>		
The Rev. R. Willis, M.A., F.R.S. - - -	4654-4699	298-300
Alfred Newton, Esq., M.A., F.R.S. - - -	4700-4818	300-304
<i>Wednesday, 7th December 1870.</i>		
The Very Rev. Robert Scott, D.D. - - -	4819-4879	305-308
Thomas Thomson, Esq., M.D., F.R.S. - - -	4880-4945	308-311
<i>Thursday, 9th February 1871.</i>		
The Rev. William Henry Bateson, D.D. - - -	4946-4993	311-313
The Rev. William Hepworth Thompson, D.D. - - -	4994-5029	313-315
The Rev. Coutts Trotter, M.A. - - -	5030-5101	315-318
<i>Friday, 10th February 1871.</i>		
The Rev. Henry Wilkinson Cookson, D.D. - - -	5102-5191	318-323
The Rev. Henry Latham, M.A. - - -	5192-5279	323-330
The Rev. Edward Atkinson, D.D. - - -	5280-5308	330-332
<i>Monday, 13th February 1871.</i>		
The Rev. Thomas George Bonney, B.D., F.S.A., F.G.S. -	5309-5461	332-342
The Rev. James Cartmell, D.D. - - -	5462-5545	342-347
The Rev. William George Clark, M.A. - - -	5546-5591	347-350
<i>Tuesday, 14th February 1871.</i>		
The Rev. Robert Phelps, D.D. - - -	5592-5666	350-354
Edward Frankland, Esq., D.C.L., Ph.D., F.R.S. - -	5667-5896	354-373
John Frederick Iselin, Esq., M.A. - - -	5897-5952	373-376
<i>Friday, 17th February 1871.</i>		
/ Henry Cole, Esq., C.B., and Capt. J. F. D. Donnelly, R.E. -	5953-6112	377-391
Henry H. Sales, Esq. - - -	6113-6235	391-400
<i>Thursday, 9th March 1871.</i>		
Louis C. Miall, Esq. - - -	6236-6323	401-407
Thomas Coomber, Esq. - - -	6324-6431 <sup>a</sup>	408-415
Capt. J. F. D. Donnelly, R.E. - - -	6432-6487	415-419
<i>Monday, 13th March 1871.</i>		
John Winter Jones, Esq., F.S.A. - - -	6488-6586	420-426
Richard Owen, Esq., M.D., F.R.S. - - -	6587-6656	426-434
<i>Tuesday, 14th March 1871.</i>		
Joseph D. Hooker, Esq., M.D., C.B., F.R.S. - - -	6657-6768	434-439
Philip Lutley Selater, Esq., Ph.D., F.R.S. - - -	6769-6843	439-444
Professor Flower, F.R.S. - - -	6844-6875	444-447
<i>Monday, 20th March 1871.</i>		
William Grylls Adams, Esq., M.A. - - -	6876-7002	447-454
John William Cunningham, Esq. - - -	7003-7078	454-457
The Rev. Alfred Barry, D.D. - - -	7079-7128	457-461
<i>Tuesday, 21st March 1871.</i>		
John Robson, Esq., B.A. - - -	7129-7158	462-466
Dr. Alexander William Williamson, F.R.S. - - -	7159-7202	466-469
<i>Tuesday, 28th March 1871.</i>		
George Bentham, Esq., F.R.S. - - -	7203-7212	469-471
John Ball, Esq., M.A., F.R.S. - - -	7213-7238	471-473
Thomas Thomeon, Esq., M.D., F.R.S. - - -	7239-7249	474



	Questions.	Pages.
<i>Friday, 31st March 1871.</i>		
J. Gouge Greenwood, Esq., B.A. - - - -	7250-7362	475-497
Henry Enfield Roscoe, Esq., B.A., Ph.D., F.R.S. - -	7363-7439	497-514
<i>Tuesday, 25th April 1871.</i>		
Warrington W. Smyth, Esq., M.A., F.R.S. - - -	7440-7452	514-515
Nevil S. Maskelyne, Esq., M.A., F.R.S. - - -	7453-7518	515-521
Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S. -	7519-7582	521-524
<i>Friday, 28th April 1871.</i>		
Peter Martin Duncan, Esq., M.B., London, F.R.S., F.G.S. -	7583-7713	524-529
William Carruthers, Esq., F.R.S. - - - -	7714-7760	529-533
George Robert Waterhouse, Esq. - - - -	7761-7778	533-534
<i>Tuesday, 2d May 1871.</i>		
George Carey Foster, Esq., B.A., F.R.S. - - -	7779-7863	534-538
William Benjamin Carpenter, Esq., M.D., F.R.S. - -	7864-7902	538-542
The Rev. John G. Cromwell, M.A. - - - -	7903-8031	542-551
<i>Friday, 5th May 1871.</i>		
The Rev. James Harrison Rigg, D.D. - - - -	8032-8099	551-559
The Rev. William J. Unwin, M.A., LL.D. - - -	8100-8158	559-562
Alfred Bourne, Esq., B.A. - - - -	8160-8206	562-565
<i>Tuesday, 9th May 1871.</i>		
The Rev. Canon Robinson, M.A. - - - -	8207-8286	565-572
<i>Friday, 12th May 1871.</i>		
The Right Rev. James Fraser, D.D., Lord Bishop of Manchester -	8287-8359	572-577
Sir Francis R. Sandford - - - -	8360-8464	577-582
<i>Tuesday, 16th May 1871.</i>		
The Rev. Canon Norris - - - -	8465-8607	582-589
The Rev. Frederick Watkins - - - -	8608-8724	589-594
<i>Friday, May 19th 1871.</i>		
William Ellis, Esq. - - - -	8725-8756	594-599
The Very Rev. William Charles Lake, D.D., Dean of Durham -	8757-8841	599-604
<i>Tuesday, 13th June 1871.</i>		
Mr. George Jarmain - - - -	8842-9000	604-609
P. Le Neve Foster, Esq., M.A. - - - -	9001-9054	609-612
<i>Friday, 23d June 1871.</i>		
Henry Cole, Esq., C.B. - - - -	9055-9148	612-622
<i>Tuesday, 11th July 1871.</i>		
Isaac Lowthian Bell, Esq. - - - -	9149-9201	622-626
Sir William G. Armstrong, C.B., D.C.L., F.R.S. -	9202-9261	627-629







# MINUTES OF EVIDENCE

TAKEN BEFORE THE

## ROYAL COMMISSION

ON

### SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

No. 6, Old Palace Yard, Westminster, Tuesday, 14th June 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

HENRY COLE, Esq., C.B., examined.

1. (*Chairman.*) I believe you are the secretary of the Science and Art Department of the Committee of Council on Education?—I am.

2. Will you be so good as to state to the Commissioners the purposes for which that department was founded, and the measures which have been taken to give effect to those purposes?—I presume that the Commissioners would hardly desire that the whole of the evidence which was given before the Committee of the House of Commons in 1868 should be repeated at full length on this occasion. I would refer the Commissioners generally to the minutes of evidence of the House of Commons' Committee of 1868, when, so far as science is concerned, Captain Donnelly, who looks after the business of science especially, and myself as secretary, made a clean breast of all that we had to say upon the subject. I would say that the Commission would find in the Science Directory a full account of the minute rules by which we are guided in distributing public money for the encouragement of science. If I have to begin at the beginning of things in respect of science, I must call the attention of the Commissioners to the speech of the Queen in 1853, who then, by the advice of Her government, declared that the time had come when the nation should systematise scientific instruction having a bearing upon industry. That was at the opening of the session of 1853; after Her Majesty's speech, Lord Aberdeen's government took the subject into consideration, and after a correspondence with the Board of Trade they enlarged the department, called the Department of Practical Art, into the Department of Science and Art, which was then founded as set forth at length in a letter from the Board of Trade, dated the 16th of March 1853, upon the ideas then held, and on which the Treasury passed a minute about the same time. I do not find that there is a precise date attached to it, but I have no doubt it was with a covering letter to which there is a date. At all events it must have been in April 1853. I had better, with your Grace's leave, perhaps, read a few passages from the minute which is to be found in Appendix A, to the First

Report of the Department of Science and Art, page 9. The object was to extend the system of encouragement to local institutions for practical science in this country, similar to that already commenced in the Department of Practical Art, and to make arrangements for furnishing, through the instrumentality of one department of the executive government, a means for mutual co-operation and correspondence to every district of the kingdom, where the local intelligence and energy of the inhabitants shall create schools of industrial science and art. It goes on to recommend uniting into one estimate the charges for the Geological Museum, and the Museums of Practical Geology in London and Dublin. The minute further says that the Treasury "agree that that object will be best attained by the "creation in the metropolis of a school of the highest "class, capable of affording the best instruction, and "the most perfect training, which can alone be hoped "for from an institution which has the command of "the most eminent and distinguished talent, the "advantages of which will be experienced by minor "institutions throughout the kingdom, not only as "furnishing a central source of information, but as "a means of furnishing competent and well qualified "teachers for local institutions, and of completing "the education of pupils who desire higher accomplishments than can reasonably be expected from "minor schools." That creation of a central science school continues at present only in words, there is no central science school. Various attempts were made after the passing of this minute to create what were then called Trade Schools in the country. After a few years they did not very well succeed, and when the late Lord Salisbury became Lord President of the Council, he formed a very strong intention that he would either abolish the word Science out of the title of the department, or he would cause some science to be given to the country. Accordingly about the year 1859, certain principles were laid down which enabled the department to encourage the teaching of certain sciences assumed to have a direct bearing upon industry throughout the country. The principles then laid down have been carried much further. The

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14 June 1870



H. G. M. Esq.  
C. M.  
16 June 1870

Commission will see from the annual reports of the department, and from a paper which I have furnished to the secretary, containing the substance of what I apprehend may be in the next report about to be presented to Parliament (see Appendix I.), the growth of the science system throughout the country as now in action. Briefly, I may say, that from 1860, when the science classes were nine, they increased in 1865 to 120 schools. They have now increased to more than 800, and to 30,000 persons receiving instruction. In stating the numbers broadly, I am giving the results of the information that we have obtained up to the present time. The system at work, briefly and broadly stated, is that any locality that pleases may establish a science school or a class for teaching science. It may hold it in a garret, or it may hold it in a cellar, and the department does not concern itself with any part of that question, unless indeed it should be asked to make a grant in aid of the building. The teachers are solely appointed by the local committees. The teachers must have proved a certain amount of competency before, by examination. The local committee gives notice to the department that it has constituted itself, and that it is a school or class for teaching science. It may teach any of the 23 sciences that are named in the directory, any one or all, and request that at a certain period of the year their students may be examined. The examination is conducted by papers sent down from the office in London, and on the results of those examinations the teachers get payments and the students get prizes. The payments are made on behalf of those who are interpreted to belong to the artizan class, the interpretation being fully stated in the directory, but the prizes are open to all classes. The theory is that the artizan class pay moderate fees, and that the middle classes, so far as they attend those schools, pay larger fees. The Commission have before them maps, which it is proposed to attach to the annual report of this year, showing by two colours, red and blue, the number of schools or centres for obtaining instruction in science and art throughout the United Kingdom. That system has prospered beyond the most sanguine expectation. In addition to that system there is a School of Mines in Jermyn Street, there is a School of Naval Architects and Marine Engineering at South Kensington, and there is besides a College of Science (established within the last three years) at Dublin. This was more or less organised out of old materials and re-formed upon the recommendations of a Commission of which the late Lord Rosse was the chairman. Very briefly that is an outline of our present state.

3. You say that the science schools throughout the country have prospered beyond your anticipations; do you mean in the amount of scientific instruction imparted, or in the number of schools that avail themselves of those advantages which are offered to them?—The number speaks for itself, but the character of the instruction would be best spoken to by the various examiners.

4. Have the scientific attainments of those who are instructed in those schools been advancing?—I am of opinion that the character of the examinations at the present time is much higher than what it was when the system was first established.

5. What are the departments of science which are chiefly attended to in those schools; do they vary very much in different schools, or is the character of the schools pretty much the same?—The variety of the schools from different points of view is very great indeed.

6. What are the branches of science which are most cultivated in those schools?—I think it would be as well if I were to put on my evidence this brief statement. I am reading now from the report about to be presented to Parliament. At the present time, in physical geography there are 219 classes and 7,091 students. In machine construction and drawing 247 classes and 6,507 students. In practical plane and

solid geometry 257 classes and 6,393 students. In animal physiology 220 classes and 6,101 students. In building construction and naval architecture 226 classes and 5,413 students. In pure mathematics 227 classes and 5,240 students. In inorganic chemistry 191 classes and 5,125 students. In magnetism and electricity 170 classes and 4,582 students. In acoustics, light, and heat, 134 classes and 3,256 students. In applied mechanics 47 classes and 1,345 students. In geology 64 classes and 1,646 students. In theoretical mechanics, 57 classes and 1,052 students. In steam 25 classes and 900 students. In organic chemistry 22 classes and 867 students. In vegetable anatomy and physiology 27 classes and 712 students. In navigation 22 classes and 536 students. In nautical astronomy 8 classes and 349 students. In systematic and economic botany 14 classes and 310 students. In zoology 8 classes and 151 students. In mineralogy, 8 classes and 135 students. In metallurgy 7 classes and 74 students; and in mining 4 classes and 40 students. Then the results of the science school examinations in May 1868 and 1869 are as follow:—The number of schools under teachers examined was 300 in 1868, and 523 in 1869. The number of classes in the same, 856 in 1868 and 1,489 in 1869. The number of individuals under instruction in classes under certificated teachers, 15,010 in 1868 and 24,865 in 1869. The number of the above who came up for examination was 6,875 in 1868, and 12,988 in 1869. The number examined in addition to the above, who were not in schools under certificated teachers, was 217 in 1868 and 246 in 1869. That means, that any persons may come up to these examinations that think fit, although they may not belong to the schools. Then the number of papers worked in each subject is given in detail under each of the subjects which I have read out, the total being 13,112 in 1868 and 24,085 in 1869.

7. Are the Commission to understand that the whole of the amount of pecuniary aid furnished by the Government is confined to payments on results, or are the Government funds applied to any other purposes connected with this department?—I had better refer your Grace to the estimates, class 4, page 276, for the year 1870-71. In respect of science the estimate is divided under "payments to teachers on results," which I have alluded to, 24,000*l.*, for the present year, "prizes of books, instruments, medals, &c., 2,400*l.*"—those are open to all classes of the community—"Grants for examples, 700*l.*" A class or a school which seeks to teach a subject requiring examples makes an application in the proper form, and all the red tape being completed, it gets 50 per cent. towards the cost of those examples. "Local secretaries for examinations, paid by the day and incidents, 2,500*l.*" In order to have due responsibility in carrying out the correspondence the local secretaries are paid a fee for each examination. Besides these sums there are 1,200*l.* for scholarships of 50*l.* a year, which are awarded in competition, and some other smaller scholarships of the value of 5*l.* and 10*l.*, which are created partly by Government money, and partly by contributions from localities of an equivalent amount, and finally there are building grants at the rate of 2*s.* 6*d.* per superficial foot, given under certain conditions, for which this year 2,000*l.* is asked, making in respect of schools of science a total of 32,800*l.* for this system, to which I have particularly alluded. There are other payments on the estimates for other matters which are scientific. I must say in addition to that, under the head of preparation of papers for examination, both for science and art, the sum is large, 4,100*l.*, and with regard to the inspection of those local schools of science and art, although the staff is extremely small, still the cost is considerable, because our system is this: just before and during the examinations of those science schools we obtain the aid of various Engineer officers who are stationed throughout the country, who visit the schools and see that everything is going on right. We have only two official inspectors of science and art, and



two inspectors of local schools, who are permanent officers employed all the year round; but I suppose that during this last month of May there must have been something like from 60 to 70 Engineer and other military officers, whose services were obtained for only two or three days at the time, to go round and see that everything was right.

8. Are those military officers expected to take part in the examinations?—They take part this much, that they go in and see that the proper number of local Committee-men are present, and see that the persons under examination are sitting properly apart. They go in perhaps just at the conclusion of the examination, or just at the beginning of the examination, to see that the red tape of opening the papers, sealing them up, &c., is going on right, and sometimes they hold a meeting of the committee if they find a screw loose, and they endeavour to put things right. I suppose we might say upon the average that every school is visited once in a year in this sort of way, and perhaps one out of three examinations have been visited by military officers.

9. Has each school three examinations annually?—No, there are 23 subjects, and a school may have 23 nights of examination, and about one in three, taking the average of the whole country, has been inspected in the way I have mentioned.

10. In that statement of the expenses with which you have just furnished us, was there any sum included for buildings?—Yes; 2,000*l.* for building grants.

11. Does that vary very much from year to year?—It is a recent introduction. We have had building grants for art from the beginning, but for science they are a novelty of not more than two years standing: and these building grants are likely to increase.

12. Have the schools been generally carried on in existing buildings provided for educational purposes of other kinds?—They have been carried on in mechanics' institutes, in literary and scientific institutions, in elementary schools during the night, and even in private houses.

13. Is the cost of the examiners also included?—Yes, always; 4,000*l.* was the sum mentioned. I have another item of expense. There is a large item of 5,300*l.* for "travelling expenses of inspectors, masters, local teachers," &c. Of course this inspection which I have described absorbs a considerable portion of the expenses. Then the masters are sometimes summoned to London; not often, but during the last two years a selection of the local teachers in certain subjects has been brought up to London at an expense of 1,500*l.*, to get the benefit of some instruction in teaching, especially in certain subjects, with an exemplification of the modes of using apparatus, making simple experiments and matters of that kind, in which it was found that they were very deficient. Formerly, when the system was small, we were accustomed to bring the teachers of chemistry up to Kensington to undergo a *viva voce* examination as well as an examination in analyses and matters of that kind, but we found that although the numbers increased our premises did not increase, and that the stinks they made were such a horrible nuisance to the whole museum that we were obliged, and most unwillingly, to give it up. It was and is the intention that in those buildings which are being erected for the School of Naval Architecture and Science we should be able to carry on those examinations of teachers in chemistry, and then it is hoped that we shall renew it. Last year they came up in a scrambling way, and did the best they could in a week or fortnight at the College of Chemistry, but it can hardly be said to be well systematised.

14. Are the masters in the first instance selected locally by those who establish the schools?—Yes, always.

15. And has the department a direct veto upon their appointment?—No, we exercise no voice at all until the question of paying comes.

16. You do not furnish them with any certificate that they are well qualified to undertake the duty of master?—They must have passed an examination of a certain grade, or they cannot get the payment, but we do not say whether A, B, C, or D should be selected. The fact is that the system works very much upon the commercial principle. A man gets an examination of a certain grade which qualifies him to teach, and he finds it worth his while to add, in most cases, teaching to his other occupations; there are few cases comparatively where a teacher gets his living entirely by teaching science. In most cases it is supplementary to other occupations.

17. What is your opinion, speaking generally, of the qualifications of those teachers for the duties which they undertake?—I suppose that the examiners passing a great number of papers as being worth State money is the best proof that the teachers do their work adequately well. It is necessarily a rough and ready process, but it seems to have commended itself somehow to the country.

18. Have you any means of tracing what has become of some of the earlier pupils who have been educated at those schools, what they have done with themselves afterwards, whether in consequence of the training they have received there they have rendered themselves useful in the various departments of life?—The best of them come to the surface and get scholarships, and I should hazard the prediction that they turn into science teachers, who make teaching the business of their life. I have some instances within my recollection of young people whose ability has first been manifested at those examinations, who, taking several high positions in different examinations, became qualified to obtain scholarships, and studied afterwards, either in the School of Mines or at the College of Science in Dublin, and then, having completed their curriculum, have become to a certain extent professors and teachers, earning their living wholly by teaching. I should instance those; there is also evidence that manufacturers are beginning to employ those persons who have distinguished themselves in examinations. In the last report there is an instance of a man being taken into partnership by a manufacturer in respect of his science.

19. I hardly gather from the answer that you gave to the first question, to what extent your office is connected with the more advanced scientific instruction which is also connected with the department?—In respect of the School of Mines, the Lord President is responsible for the public money paid over according to the votes of Parliament for the administration of the School of Mines. The Lord President is responsible for the appointments, and makes the appointments, but beyond that, in a vague way, there is not very much of what I should call meddling between the department and the School of Mines. The same answer applies also to the College of Science in Dublin. Perhaps that, being a new institution, and being in Ireland, has required a little more administration than the School of Mines, which indeed was created before the department was formed. Excepting so far as furnishing parliamentary responsibility, I do not think that there is very much connexion, or not a very minute connexion, between them and the department.

20. Your direct duties are more concerned with elementary than advanced scientific instruction?—That, by the force of circumstances, has become a very important function of the Science and Art Department. We, in fact, are what may be called the purveyors of science in some shapes.

21. (*Mr. Samuelson.*) Who is responsible for the appendix No. 1?—The officials of the department are responsible for it.

22. You say that the teachers have evinced a certain amount of competency. I would ask you whether the department is satisfied with that amount of competency?—I should say "no," from one point of view, and "yes" from another. If you ask me whether there is a good stock of very competent teachers for

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C.B.

14 June 1870.



H. Cole, Esq.,  
C.B.  
14 June 1870.

the scientific instruction of this country. I say that there is but a feeble staff; if, however, you ask me whether the country being satisfied with getting this small night instruction, the teachers are well up to giving that night instruction, and producing the results now produced, then I say yes. If you do not want the system to go further than it has, I think that the present system answers pretty fairly. In fact I do not see how it can be very well improved, but if there be any kind of intention of securing a science system more advanced than this night instruction, then it is most insufficient.

23. Would you say that your present teachers on the average are qualified to give sound elementary instruction in science or not?—I must leave that answer to be given by the examiners. I cannot pretend to say whether the instruction is sound or not, but as far as it goes, it being as I say a loose kind of system, a free and easy system, my own opinion, if it is worth anything, is, that it acts very well, but I do not admit at all that it is that it might be.

24. The reports of the examiners of course have been under your consideration?—Yes.

25. Will you have the goodness to state whether those reports are upon the whole satisfactory?—I should say so, bearing in mind what the system is. The system is entirely a voluntary system. Young men throughout the country, who are engaged for the most part in daily labour, are impelled to acquire what amount of science they can by attending night classes during the autumn months of the year. There cannot be the slightest doubt that as those people toil, pay fees, and come up for examination, and produce papers which the examiners put a value upon, an amount of good is being done. If you ask me whether it provides that extended scientific instruction which young men who wish to obtain scientific knowledge to go into industry ought to have, I say that it does not adequately provide it.

26. Will you state a little more in detail than you did in answer to his Grace, what are the qualifications demanded of teachers by the department?—No qualifications except those of having been examined. They are examined in advanced stages of the examination papers, that is all the qualification.

27. It was the case, I think, that at a former period there was a special examination for teachers, was there not?—Yes.

28. Can you state what relation the present examination in an advanced stage bears to what was formerly the standard of that special examination?—It is of course difficult to say positively, but I should think that perhaps the lowest that pass now are not as good as the best of the teachers who passed at that time; but I think that when there was a special examination of the teachers, a good many passed who were not so well qualified as those who pass now in the first class of the advanced stage.

29. (*Professor Huxley.*) Was it not the case formerly that teachers were required in the first place to pass a written examination?—That was the first stage.

30. And secondly they had a *vivâ voce* examination?—For a time that was so; but afterwards a great difficulty was found in bringing them all up to London. Therefore, centres of examination for teachers were established in London, Edinburgh, Dublin, and Manchester, and then the *vivâ voce* examination ceased.

31. So that in the time to which I am referring, there was a written examination and a *vivâ voce* examination, and in those subjects that admitted of it, to a certain extent, a practical examination?—Yes, for the first portion of the time; but the practical examination and the *vivâ voce* examination ceased. Then the next stage was doing away with the special examination of teachers altogether.

32. (*Mr. Samuelson.*) Referring to the change that was made from the second to the third system, will you have the kindness to state what were the reasons of the department for instituting that change?—In

the first place the system entailed a large expense for which there was really no adequate return. The present examination fulfils all that you require, and as it is purely a system of payment on results the preliminary examination of the teacher is to a great extent unnecessary. The real test of a teacher is the success of his teaching, and he is only paid according to the success of his teaching, and, therefore, a preliminary examination is not of much importance.

33. The system of employing additional inspectors is new, is it not?—New within the last three years.

34. Will you have the kindness to state what led to that?—No particular incident led to it, but the general conviction that the system was getting very large, that the expenses were very much increasing, and a desire to find out any defects if defects existed, coupled also with the evidence that the committees began to think their work a bore, and that they wanted looking after in order to enable the system to go on—together with a speck or two of complaint, and some few discoveries in Ireland of an unpleasant character. A great number of small mixed considerations led the department to think that some inspection was necessary.

35. What were the discoveries of an unpleasant character to which you allude; do you mean irregularities in the conduct of the examinations?—Chiefly so, not exactly in the conduct of the examinations, but things going on irregularly. The people who are charged to look after those examinations, in some cases do not attach much importance to the necessary forms. In the case of Ireland, the secretary of a committee filled up the names of all the committee, whereas the form says that each member must sign, and thus engage to be personally responsible for the duties that he undertakes to perform; it being apparent that the names were all filled up in the handwriting of one man, although it is really a certificate,—“We the undersigned do agree to do so and so”—he was asked how he came to do it, and he said that the chairman and the other members of the committee were all friends of his, and he thought he could take the liberty, and accordingly he filled up the form. That is a rare case, but it was one of perhaps half a dozen analogous cases, which led us to think that a little inspection would be wholesome.

36. Is it not the case that some of the examiners found that the answers to the papers were so completely identical, or so nearly identical, that there must have been communication between the pupils?—Yes, there were a few cases of that kind.

37. And did not that circumstance also lead to an impression on the part of some of the examiners that there was more of what is called cramming than teaching in many of the schools?—There is a fair amount of cramming I have no doubt in these as in most examinations. It must be borne in mind that the persons chiefly examined are adults, and you may assume that their tone of morals is rather higher than that of younger people; and it is also to be remarked that, being for the most part, as we think, grown up people, it really would not answer their purpose to copy and cram for the sake of their examination. There is no question that a large per-centage of the instruction in the country in science all round is being given to adults in mechanics' institutions in the evening.

38. You stated, did you not, that instruction in teaching was given last year, I believe for the first time?—Yes.

39. And that it comprehended a week or a fortnight at the College of Chemistry?—Yes, and some instruction at Kensington.

40. Do you mean that each teacher who came up was instructed during a week or fortnight, or that the whole time occupied in instructing the teachers was a week or fortnight?—Each teacher that came up came up for at least a week, went to the College of Chemistry, and Professor Frankland did the best he could with them in a sort of class. The instruction



consisted of a course of lectures on the method of teaching physiology, by Dr. Michael Foster, a course on teaching experimental physics (light) by Dr. Guthrie, and one lecture, and a short course of laboratory practice, by Dr. Frankland at the Royal College of Chemistry in Oxford Street. Dr. Guthrie gave his lectures at the School of Mines, and Dr. Michael Foster in the lecture theatre of the South Kensington Museum. The object of those courses was more especially to show easy and cheap methods of experimental demonstration to classes. 253 students availed themselves of the lectures; of these 169 attended both courses, besides which 35 attended the course on light only, 49 that on physiology only, and 153 attended the College of Chemistry.

41. Does your memorandum include any suggestions for the improvement of the qualifications of teachers?—The memorandum from which I get these statistics is the basis of a report to Parliament upon the results of the science action during the past year; it is, therefore, hardly the place that one would make suggestions in.

42. Are you prepared yourself now to offer any suggestion upon the subject of rendering teachers better qualified for teaching?—I ventured to express my opinion before yourself as Chairman of the Committee of the House of Commons on Scientific Instruction, or rather I handed in a paper which I see no great reason to swerve from after two years' experience. In the minutes of evidence of the Committee of 1868, at page 392, it will be observed that I prepared, at the request of Mr. Samuelson, a memorandum on combining the Royal School of Mines, the Royal College of Chemistry, and the Royal School of Naval Architecture into a Metropolitan College of Science, the main object of which was that it should be a training school for teachers. In that memorandum I stated the views which seemed to me would aid in improving the class of teachers throughout the country.

43. Your proposal was that those three institutions which you have named should be amalgamated, was it not?—Yes; my opinion is that you have in the School of Mines very high scientific instruction given, partly of a general character, and partly of a special character for mining; you have in the School of Naval Architecture and Marine Engineering professors of eminence who are teaching generalities and teaching also specialities; and again, at the College of Chemistry, though that is more precise in its object, you have a good deal of general instruction. My opinion is that much economy and very greatly increased efficiency would result from combining these elements and rather extending the scope of the school. The principal object being to train teachers, I think, so far as a general school is concerned, that that is the one thing which is especially wanting at the present time, and I hardly see how it is to be obtained excepting the State undertakes to do it.

44. Do you think that that would require any large increase of the allowance from the State, or are you of opinion that the teachers would consider it worth their while to expend something on their own education?—My own opinion is that you have in the case of the Art Training School experience and analogies which would be extremely useful in a training school for science teachers. The system there is, that from all parts of the country young people who desire to be teachers come up after having proved themselves to possess a certain amount of competency, and somewhat in proportion to the competency which they have proved they get an allowance or not. If they come up from the country they begin with an allowance of 10s. a week, which goes up even to 30s. a week, as a maintenance allowance, and they pay no fees. If they live in London, students of great promise and great excellence, do get a slight maintenance, but on the whole it is less than that given to the students coming from their own homes in the country. In addition to that,

you have a number of students who desire to be teachers, who show evidence that they will be teachers of sufficient competency, and who are admitted to the school without payment of fees; and in addition to that, the public itself is allowed to come to the school and get what instruction it can upon payment of high fees; and my opinion is, that the same kind of system should be applied to a school for science—that a certain number being evolved out of the different science classes and schools throughout the country by proving their ability in a public competition, they should be encouraged to come up to town, and should be maintained whilst they are in town. That would represent something like the present system. And then I think that another class, perhaps somewhat less competent, should be admitted, both first class and second, without payment of fees. And lastly, if there be room, I think that you should allow the public to come in upon payment of very high fees.

45. How would that harmonize with the regulations now prevailing in the separate schools which you would propose to amalgamate into one school?—There is something of the kind going on in the School of Mines. You have a number of scholarships established in the School of Mines, the holders of which get State aid of 50*l.* a year, and I do not think that anything that is done in the School of Mines would be in anywise interrupted or impeded by a system of that kind. Of course it depends upon a discussion of the details by the professors, but I do not apprehend that there would be any serious difficulties about it. I think that the organisation which is now settled for the College of Science in Dublin, nearly provides for the same kind of thing in London, and I believe that it would work successfully.

46. I think you stated in your evidence before the Committee of the House of Commons, or at any rate it must have been stated within your knowledge, that the accommodation for pupils in the School of Mines and in the College of Chemistry, in Oxford Street, was below their requirements at that time, in 1868?—Yes, I believe so.

47. Has there been a falling off or an increase in the number of applicants for admission since that time?—The last account from Dr. Percy and Dr. Frankland is that in their own classes they require considerable additional space. Sir Roderick Murchison, in February 1869, submitted a letter of Dr. Percy's, in which he says he has been obliged for several years "to refuse admission to many persons who have applied to be admitted as students. During the present session I have admitted several students beyond the number for which there are suitable conveniences for work. The laboratory is not adapted for more than nine or ten; at present 15 students are at work, and 12 have been refused admission. In the early days of the institution, when it could only be regarded as an experiment, it was wise to proceed cautiously, and not incur an outlay for a laboratory, for which it was uncertain whether there would be a demand on the part of the public. That uncertainty no longer exists, as may be inferred from the facts above stated. In an institution like the School of Mines, to stand still is virtually to retrograde." The Commissioners will find in the 16th report of the Science and Art Department, page 25, a memorandum, made by Dr. Frankland in January 1869, which was submitted to the secretary of the department by Sir Roderick Murchison, in which he shows that the accommodation is very insufficient, and that he is obliged to give up teaching things which he would desire to teach. He compares his laboratory with those at Berlin and Bonn, which have recently been constructed at a cost, in the one case, exceeding 47,000*l.*, and in the other 23,000*l.*, and also at Leipzig and Zurich. He points out also that the Home Office is put to an expense of 900*l.* a year for a separate laboratory for work which he does for them, which would be rendered unnecessary if a better laboratory were provided, and this year Sir

H. Cole, Esq.,  
C.B.

14 June 1870.



H. C. D. Og.  
C. D.  
14 June 1870.

Roderick says in his report, "During the past year the number of students who have worked at practical chemistry in this college has exceeded that recorded in any previous year. The students' laboratory has very narrow accommodation for only 40 students, but by giving up the greater part of the laboratory of research, Dr. Frankland has been able to receive from three to eight in addition to the above number. Nevertheless many applicants have been reluctantly refused admission."

48. The School of Chemistry is held on a very short lease, which is about to expire, is it not?—Yes.

49. Assuming that those institutions were to be combined, where would you place them?—Of course in my mind there is no place in the world like South Kensington, but I should say that they could be most economically placed at South Kensington.

50. Is it the case or not that the work of the Geological Survey is also partly carried on in Jermyn Street in the same locality as the Mining School?—Yes.

51. And is the accommodation sufficient for that department?—Quite inadequate. We have now remonstrances from Sir Roderick Murchison that the progress of the survey is stopped for want of accommodation, and pending this inquiry the Lord President thought it not right to provide additional premises; otherwise if we do not come to a solution soon some additional lodgings must be provided for the survey.

52. Assuming that the Mining School were removed from Jermyn Street, would the accommodation then available be more than sufficient for the Geological Survey?—It would give great relief; whether it would be more than sufficient or quite sufficient I am unable to say precisely; but undoubtedly it would give relief. My impression is that it would not give quite enough.

53. There would be no room to spare?—There would be no room to spare at all.

54. You have mentioned South Kensington as the proper locality for a school of science: is any provision being made for such a school there in the way of buildings?—Not specifically for a school of science. When it was resolved to build permanent premises for the School of Naval Architecture and Science, and to get them out of their present wooden sheds, provision was made in the upper part of the building for a laboratory of considerable size, in the view of those scientific examinations, as well as bearing in mind the knowledge that Jermyn Street was overcrowded with those laboratory students as well as the College of Chemistry; but the building at Kensington was not made with the view of superseding the School of Mines in Jermyn Street. It would conduce much towards it, and with additions might be turned into a general school of science with developments into Naval Architecture and Marine Engineering and anything else that might be desired.

55. Is it necessary that the sheds to which you have referred should be abandoned?—Ten years ago Superintendent Braidwood said that they were against the law in point of security, and that nothing but a Government department would dare to have things of that kind up in use. Undoubtedly having lasted for 10 years, they would with care last a few years more. We have only had one fire, which certainly would have been very disastrous for the place, but we had a lot of sappers on the spot who put it out like cats on a roof in an unscientific way.

56. You are not of opinion that those buildings could be retained beyond a very short time?—If the Government were resolved at this instant to give effect to what it declared in theory in 1853, the creation of a metropolitan institution for science, I dare say in a year from this time we could provide accommodation for such a thing at Kensington. A considerable part might be accommodated in those new buildings, and the other part would have to be provided in those sheds, but it could hardly be done without a full intention of making a suitable place as soon as the money could be found.

57. Would there be any accommodation available in your other miscellaneous buildings?—None whatever; we are choked.

58. You have a large lecture theatre, have you not?—Yes; that of course would serve a purpose, but it could not be absorbed for lectures on science.

59. Could it be made available for instruction?—You can always make use of places a good deal, and you might make use of that.

60. But it could not be constantly used?—No, it could not be set apart as a definite place without stopping other work that is going on.

61. When will the new building of which you have spoken be completed?—That altogether depends upon the Treasury. It might be completed perhaps in 12 months from this time or less, perhaps nine months. According to the sums taken in the estimates this year, it could not be completed till the year after next, unless they are increased.

62. What is the sum on the estimates for the present year?—For the new buildings at South Kensington, the vote at page 42 of No. III. is put down at 32,500*l*.

63. That is to be divided amongst various buildings, is it not?—Yes, that is to provide for some buildings for the Art Museum, and also for the School of Naval Architecture and Science.

64. How would that be divided amongst the new buildings?—That is a question for Mr. Ayrton to answer.

65. Since when have those buildings been placed under the control of the Board of Works?—The responsibility for the buildings at Kensington was changed this spring, just before the estimates were prepared.

66. Before that who was responsible?—Before that the Lord President was responsible.

67. Are you able to tell the Commission what amounts it is intended to apply to the different buildings, or shall we get that from Mr. Ayrton?—I think you had better get it from Mr. Ayrton, as he is now responsible.

68. Have you made any estimate as to what would be ultimately required in order to adapt your present accommodation to such a metropolitan school as you have in your mind?—No, we have made no estimate of the cost of the buildings necessary for a training school for science.

69. What is to be the total cost of the present special building?—My impression is, speaking subject to correction and to better information from Colonel Scott, that the cost of the present building would be about 70,000*l*. when completed.

70. How much of that has been expended?—30,000*l*., out of which 25,000*l*. has actually been paid.

71. Could you prepare an estimate of the cost of the additions which in your opinion would be required in the shape of buildings and fittings, in order to adapt the *locale* of South Kensington to a school of science?—Yes, I will do so. [See Qu. 5953.]

72. From your knowledge of the opinions of the gentlemen holding office in Jermyn Street, and in the School of Naval Architecture, and in Oxford Street, would you say that upon the whole they are convinced that such an amalgamation as you recommend is desirable, and could be readily effected?—I am under the impression that we have grown to that conviction. I think the letters of Dr. Percy and Dr. Frankland, and the memorandum of Sir Roderick Murchison, and the conversations which I have held with the other professors, lead me to think that they would co-operate willingly now in an improvement of that kind; I think that it would have been very impracticable years ago. I think that the popular prejudice against the distance from what is called the centre of London, has nothing whatever to do with the case. The Art Training School is seven times as big, and seven times as prosperous in every respect, as it was when it was at Somerset House, and I think it is clearly proved that the public go whenever they want a



thing, no matter where it is. They go to Oxford, to Cambridge, to Glasgow, and to Edinburgh.

73. Apart from the question of locality do you think that they are convinced that a great combined school would be preferable to the separate schools which exist now?—I would rather not speak for more than I know. My impression is distinctly that three or four of the professors are of that opinion, and they would speak much better for themselves than I can do.

74. Sir Roderick Murchison is the head of the Mining School?—Sir Roderick Murchison is Director of the School of Mines. At the beginning he was Director of the Museum. I think his function was created, with a separate salary, and was called Director of the Museum; I think he is called now the Director of the School of Mines, and in addition he is the Director of the Geological Survey.

75. Are his functions as Director of the School of Mines at all analogous to those of the head of one of our great universities or of the Continental Polytechnic Schools?—I should say not; but I would greatly prefer that Sir Roderick should answer any questions of that kind. The pedagogic duty I think is not much exercised by Sir Roderick.

76. Do you think that the duties of Director of the Geological Survey and the duties of the head of a great school ought to be combined?—I should say certainly not; both of them are duties distinct in their character, requiring more or less different qualifications, and I am of opinion that no university, college, or school can be well managed without its duties are the primary function of the officer at the head of it.

77. (*Dr. Sharpey.*) I find it stated in the first report of the Science and Art Department that the great purpose of the teaching of science is its application to mining and to industry generally?—Yes; that is so.

78. Was it at all contemplated originally that there should be anything like systematic instruction in the different branches of science, apart from their applications to industry?—I should say, putting back my memory to 1853, that there was a notion then prevailing that you could have what were called trade schools, and that it was possible to have trade schools, just as they have them in several parts of Europe, for teaching sciences applied specially to industry. The Mining School, of course, is a kind of illustration. The subjects taught at the Mining School are supposed, and I presume justly supposed, to have an especial bearing upon mining. I think all experience has shown that unless you have the foundation of a good general scientific instruction you hardly accomplish the special object in view, and I think all experience proves that the application of the sciences had better be left, as far as possible, for the public itself to determine, rather than for any institution to attempt to decide. I do not wish by any means to imply that the School of Mines, or that the School of Naval Architecture should be abolished, but I am quite sure that neither school can efficiently exist without securing for the students at those schools a great deal of general science instruction also.

79. Your answer applies to metallurgy, does it not?—Yes, it applies to metallurgy and to chemistry as applied to the arts.

80. Was it ever contemplated that that primary training in general science might be obtained in the ordinary way through existing institutions, and the proficiency of the candidates for admission to the school in Jermyn Street tested by examination?—I have a difficulty in answering for the concoctors of this scheme which was produced in 1853, and I would respectfully refer the Commission to Dr. Playfair who had more to do with it than I had. I strongly hold the opinion that unless the general basis of science is sound you cannot get at the special application of it with any satisfaction.

81. Do you think it necessary that there should be any general science in a special school?—I should say that I think it indispensable. I do not mean by that that you should teach A.B. and C. D. what is the begin-

ning of things, or that you should teach the three R's, certainly not in a training school for teachers; the idea that I have always had present to me is that I would not admit them to that school unless they showed very considerable knowledge of general science before they were admitted; I believe it is found that the School of Mines would be a better school of mines if they enforced some mathematical teaching there. The application of Sir Roderick Murchison has frequently come before our Board, for the appointment of a professor of mathematics in fact I have understood that the students that come there are willing to pay fees for special instruction in mining, but that they come insufficiently prepared in some generalities which are necessary.

82. I think you have already stated that what is wanted before turning the attention of the pupil to special applications of science, is an acquaintance with the principles of the different branches of science generally?—Yes, certainly.

83. My question was whether it is indispensable that that preliminary instruction should be given in a central school of science, or whether it might not be permitted to be obtained wherever there is an opportunity, that is to say, that a person might present himself as a candidate for admission to the School of Science, and receive his special instruction in the School of Science, provided he could show his proficiency in general science, no matter where he had received his previous instruction?—My opinion is strongly in favour of that. I confine my observation to what I call a training school for teachers, and I think that that is the one thing that cannot well be got excepting through a special institution. The acquisition of general knowledge, and the power of efficiently imparting it, are two different things. I believe that the general knowledge can be acquired in many places in England and some places in London, but that all the incidents connected with the application of that knowledge, and all the different modes of teaching, the different uses of apparatus in reference to teaching, and communicating that knowledge rather than the general acquirement satisfy me that you must have a special institution for the training, and when I speak of a school of science I mean a training school for teachers in science. I do not go beyond that idea at all.

84. A training school for teachers in science is the purpose of this great school of science that you contemplate?—Yes; I find that the world is asking largely for increased scientific instruction, and I think they are getting some crumbs of it at the present time through the present system, but I think a great deal more has to be done, and I think the foundation for the future is the creation of competent teachers.

85. I find in the appendix to the first report of the Science and Art Department, at page 415, it is stated that "the Lords of the Committee of Privy Council for Trade have fully kept in view that principle of the department which avoids interfering with independent action, and encourages to the fullest possible extent self-supporting institutions." With regard to the School of the College of Chemistry has that been followed out?—My opinion would be that it has not; that the College of Chemistry may, from some points of view, be considered as competing with existing institutions. I never had to help to invent the College of Chemistry, and I have never been asked any opinions about it. I know little of it, excepting that I believe its staff is efficient, but whether chemistry is such a speciality that the Government should spend the taxes in promoting a College of Chemistry by itself, is a question upon which I have never been asked any opinion. If I were asked whether the Government should encourage a knowledge of chemistry throughout the country for the good of industry, upon that broad proposition, I hold a strong faith that they ought. There is some difficulty about how it is to be done. I really have not formed a definite opinion upon the question

H. Cole, Esq.,  
C.B.

14 June 1870.



H. C. & Esq., of the necessary existence of a College of Chemistry. I am inclined to say "No."

86. There can be no question of the efficiency of it under its present management, or under its previous management by Dr. Hofmann, we all know that, but if I rightly remember, and indeed I see it upon the documents before me, the College of Chemistry was originally instituted as an independent establishment by subscribers, and it went on for some years as an independent establishment, self-supporting, partly by fees, and partly by the subscriptions of its promoters, but in the course of a few years it failed, and then I think it was incorporated with the Science and Art Department, the Government taking the lease of the premises, and paying 3,000*l.* for the plant and fixtures, and so forth; but still, if I understand rightly the statements in this report, it was intended that it should be in a great measure self-supporting?—So I apprehend it is to a great extent. There were a number of mixed considerations which led the Government to take up with the College of Chemistry of which I really have hardly much more than a traditional kind of impression. I understand your question not to go to the precise items, but to the principle. The college is to a large extent self-supporting, and it costs about 1,200*l.*

87. At page 45 in the first report, it is stated that the school, that is the College of Chemistry, "is conducted" on a self-supporting principle, its whole working expenses being paid by the fees of pupils. The profits after having reached the amount of 500*l.* for remuneration to the professor being divided into two parts, one moiety of which goes to increase the salary of the professor, the other passing to the Government." I apprehend that the present professor receives a salary?—Yes, he receives 300*l.*, a year, and he has an assistant at 100*l.* rising to 150*l.* and I apprehend the theory is that a professor of chemistry is indispensable for a course of instruction in mining. I find that he is charged under the head of School of Mines and Geological Museum.

88. I am informed that the professor's salary of 300*l.* a year, is not as conducting the School of Chemistry simply with reference to industry and art generally, but in reference to the School of Mines?—I apprehend so. That happened before the College of Chemistry was merged into the School of Mines. Then there were two chemists and a metallurgist. I think at that time Dr. Playfair was the chemist in the School of Mines, and I think that Dr. Percy was metallurgist on the establishment of the School of Mines. When the Science and Art Department was created, Dr. Playfair was taken to be secretary and inspector for science, and Dr. Hofmann was elected in his place. At that time, I think, the School of Chemistry was not over prosperous; it was struggling on. The late Lord Ashburton took a great deal of interest in it, and helped it I think.

89. Are you now speaking of the School of Chemistry connected with the School of Mines or of the College of Chemistry?—I am speaking of the College of Chemistry. It being necessary to secure Dr. Hofmann, it was as a sort of compliment to Dr. Hofmann that the College of Chemistry should be associated with the School of Mines.

90. So that in point of fact it was in order to obtain the services of Dr. Hofmann that the Government adopted the College of Chemistry into the system?—Speaking from recollection and a traditional knowledge only, I am under the impression that in order to obtain the services of Dr. Hofmann it was considered necessary to take over the College of Chemistry, which was not in a flourishing state, and to provide room which in fact was inadequate; there was no room in Jernyn Street.

91. I presume that there have been considerable additions made to the accommodation since the College of Chemistry was adopted into the Science and Art Department; has there not been a theatre built by the Government?—I do not think that there has been anything material in the way of change of premises of

the College of Chemistry. In 1858 an open court was formed into a lecture theatre, by putting a glass roof over and fitting up benches. This had formed part of the original design when the college was first built in 1846, and great inconvenience was experienced in the early years of the college from want of it, but in consequence of the opposition of neighbours it could not be built. The objecting parties having died or disappeared, the Government was able to carry out in 1856 what the Council of the Royal College of Chemistry originally intended to do.

92. Perhaps you will explain what is exactly meant by a self-supporting principle, seeing that those large subsidies are given from the State for teaching chemistry in this school?—I understand that the professor of chemistry at the School of Mines gets a salary, he would get a salary as lecturer to the School of Mines, and probably in addition to that he has charge of the separate institution which is in Oxford Street. It is true that the State appears to give about 800*l.* a year towards the local expenses of the College of Chemistry. That undoubtedly is a payment in aid of it; and then the fees of the students pay for the expenses of the laboratory, and remunerate the professor.

93. I see that there is a charge for fuel, gas, and various things of that sort; are the fees paid into the exchequer and then an allowance made from them?—The professors divide the fees. I am unable to say whether the whole of the fees for chemistry are put into the general purse, or whether a deduction is made for the expenses of the laboratory first.

94. But those fees are not paid into the exchequer?—No.

95. And there is 800*l.* a year received from the State for maintaining this institution?—800*l.* is for what they call the local expenses, insurance, rates, furniture, repairs, fuel, and light.

96. That is quite independent of the salary of the professor and his assistants?—Quite so.

97. Going back again to the principle which was announced at the beginning, in the report of the Department, in which it is said to be a principle with the Lords of the Privy Council not to interfere with the independent action of independent institutions, whilst in fact the Government has in this case apparently taken the teaching of chemistry into its own hand, and is maintaining it at the public expense to a very considerable extent; that is scarcely consistent is it with the original statement of the department?—I think that the circumstances under which the college was united to the School of Mines have to be borne in mind. I do not apprehend that in 1853 the Government would ever have proposed to have taken up the teaching of chemistry *per se*, but having no adequate premises for teaching chemistry applied to the Arts or applied to Mining, the Government of the day purchased as it were the rights of this college of chemistry, but I apprehend it was really more a question of getting Dr. Hofmann than a want of local accommodation, or than a desire of entering into competition with any other establishment. In point of fact, that it was competition, so far as it was a separate establishment, no one can gainsay.

98. But at present I presume that many of the pupils who frequent the School of Chemistry are not at all necessarily intended for industrial pursuits or for mining pursuits?—I am unable to speak to that point. Some of the students hold scholarships, and on behalf of those students no fees are paid at all; therefore there is to a certain extent a public return for the salary in respect of the instruction of those students.

99. A student who in the country obtains a scholarship can only obtain gratuitous instruction by going to the Government establishment; the Government of course would not pay for his instruction anywhere else?—We have not arrived at that yet.

100. (*Professor Huxley.*) I think you said that the



School of Mines grew out of the Geological Survey?—Yes.

101. In fact it was originated mainly by the efforts of the late Sir Henry De La Beche?—Yes.

102. And those efforts were in a great measure prompted by memorials received from the mining districts in different parts of the country, urging the Government to establish a technical school for mining?—I believe so.

103. In fact, when the Royal School of Mines was established in 1851, it was, I presume, the first technical school that the Government had set up in this country?—Yes, the first for which the State was wholly responsible.

104. It was originally termed, was it not, the Government School of Mines and of Science applied to the Arts?—That I believe was an early name, but whether the original one or not, I am not aware. I know nothing to the contrary.

105. You are aware that when the school was originally instituted there were chairs of physics, of chemistry, and of natural history, in the school?—Yes.

106. All of which chairs were chairs of general science?—Yes.

107. It being thought by the founders of that school, as I presume it would be thought by the founders of all technical schools that are worthy of the name, that technical science must be made subordinate to general science?—Yes.

108. Do you think it would be desirable or practicable when the Government have established such a college that they should put a veto upon anybody except students specially intended for mining, attending the general courses; should they have shut out the public from all benefit of the general theoretical instruction to be gained there?—I think not.

109. You are aware, I daresay, that some two years after the establishment of the School of Mines under the auspices of Dr. Playfair, who was then secretary of the Department for Science, the title of the college was changed, and it was called the Metropolitan School of Science applied to Mining and the Arts?—Yes, I believe so.

110. The meaning of that being that the Government of that day really desired to convert it into a general school of science?—That was the desire.

111. You may have heard that the professors of the school at that time greatly objected to that change, in fact that it produced a considerable amount of disunion, if I may say so, between the department and the body of professors?—Such was the rumour.

112. For two reasons; first, because we had a very definite object to begin with, and, secondly, because there was, even at that time, a considerable amount of jealousy on the part of other scientific bodies which we did not wish to increase. Those were the reasons which anyone who is acquainted with the working of the department is currently aware were at the bottom of that disagreement between the department and the body of professors?—Yes.

113. Clearly, therefore, there was no desire at that time on the part of the professors to change the character of the institution, but rather a desire to avoid any possible conflict?—Yes.

114. I should be glad to hear your general opinion (because we are certain to have the question before us in many ways) about State competition with private enterprise; do you think that State competition with private enterprise in the matter of education is absolutely bad in all senses and degrees?—I do not think that education broadly is to be dealt with on the ordinary rules of political economy. I think that the Government should not do what it finds its subjects doing quite as well without its aid, but I have yet to learn that the teaching, even of the three R's, might be accomplished without the aid of the State in some way. I fully admit the principle that it is not desirable for the State to do anything which it finds well done without its aid, but if certain things themselves are desirable and not done, I think then it becomes a question how far the State should intervene. If I am asked

whether, assuming it to be the public opinion, at the present time it is necessary for the progress and welfare of this country that more science should be introduced into the instruction of the country, and if I am asked whether that is likely to come about by what you would call private enterprise, I am strongly of opinion that it will not come about in that way. I am of opinion that the State, even in bringing that about as a national duty, should to the utmost employ and encourage all the agencies which tend to do the work for themselves which it desires to have done, and I should greatly regret to see State institutions established over the whole country, and governed entirely as State institutions, without reference to local wishes and local action. I believe that it would not encourage science. I believe that all establishments of that kind are of doubtful good, and that State action, independently of any action on behalf of the subjects of the State, is a fallacy. That system is to be found illustrated in France largely. Where the State puts down a school, and pays the professors and pays the establishment, it does not really as it were respond to the wants of the locality, but rather imposes its own theories respecting them. I think that leads to a failure, but I emphatically think that there are duties belonging to the State which are not to be governed by the dry maxims of political economy.

115. You are doubtless aware that the professorships in the Scotch universities are to a very great extent regius professorships?—I am. I laid before Mr. Samuelson's Committee, as well as I could make out at the time, the total amounts paid for encouraging certain subjects of science throughout the country. In 1867–8, the estimates showed that 951*l.* was paid for the encouragement of mathematics in various ways, in London, St. Andrew's, Glasgow, and Edinburgh; in chemistry, 1,315*l.* per annum in the Universities of London, St. Andrew's, Aberdeen, Glasgow, and Edinburgh; in natural and experimental philosophy, 751*l.* distributed among the Universities of London, St. Andrew's, Glasgow, and Edinburgh: 710*l.* for botany; 150*l.* for geology; 660*l.* for physiology, zoology, and natural history; and 275*l.* for mechanics and civil engineering. I believe that those sums go on every year. (See Appendix II.)

116. So far as those sums are paid, they are a distinct advantage, given by the State to the persons receiving them, over private competition, are they not?—Yes.

117. Are you of opinion that these aids now given by the State should be withdrawn in order to save the principle of not interfering with private enterprise?—Certainly not. Unless the State is prepared in a drastic way to withdraw all kinds of endowment for teaching things—an endowment being virtually public property—I think taking into consideration the little that is done here in respect of science, which is a comparatively modern idea, it is indispensable that the State should do this and a great deal more. I do not altogether like the mode of those regius endowments for my own part, because I think a better mode could be invented, but I am distinctly of opinion that 4,800*l.* distributed over the country in this way does not represent the tenth part of what ought to be distributed in some better way.

118. I understand you to be of opinion that the mere fact that a privately endowed body is engaged in teaching science is not in itself in your judgment a reason why the State should abstain from all fair competition with that body in so important a matter as the teaching of science is?—I think it is no reason in the present state of the world why the State should not endeavour to supplement the deficiencies of any private institution. I do not like the word in competition with them, because my view is that there need be no competition, and that the interests may be made mutual.

119. Would you apply your view to all privately endowed bodies, that is to say, irrespective of any limitations, that there may be as to the classes of the population to whom they are open; or would you be

H. Cole, Esq.  
C.B.

14 June 1870.



H. Clee, Esq.,  
C.D.  
14 June 1870.

disposed to draw a line of demarcation between a privately endowed body which is open to all classes of Her Majesty's subjects, and one which is limited by particular sectarian or other considerations? That is to say, supposing there were such a thing as a college for teaching science set up, and that it was a condition of anyone going to that college that he should be a Particular Baptist, would that be a reason why the State should not set up a separate college; would such action on the part of the State come within the limit of unfair competition?—In my view of aiding chemistry, I should not trouble myself in getting the chemistry if I got it sound and good, with the institution where it was taught. It would hardly enter into my thought. If I were asked how I would encourage chemistry, assuming that I thought chemistry were not encouraged enough for the good of the country, then I should establish scholarships which should be maintained by the State, which should be awarded in open competition everywhere, and if so be that the successful competitors were all Baptists, I should leave them to go wherever they thought fit; if they happened to belong to the Church of England, they might go to any place that taught chemistry in accordance with Church of England views, and if so be there were such a thing as a secular school and the successful candidates were secularists, they might go there; but I should not trouble myself at all with what the institution did besides the chemistry, provided that I secured the chemistry.

120. That is not quite the meaning of my question; what I mean is that I can understand that there may be a certain amount of fairness in the objection on the part of a privately endowed body, or a private institution which is open to all classes of the people without any other consideration, that the State has no right to come into crushing competition with that body; but the question which I wished to put to you was whether, if the teaching body is by its constitution limited to a particular class of persons, we will say black or white, or having this belief or that belief, whether under those circumstances it has any *locus standi* at all—whether it has a right to complain of the State doing what it can do for all classes of the people?—From one point of view it has no right at all; but I again say that I want the chemistry; I want it taught and I should leave the recipient of the chemistry to go and find it in the place where it was being taught, and I should not trouble myself with any other question than that, or with anything else than the result that it was taught, and I would not give the State money unless that were realised.

121. There are two kinds of objection to be taken to State competition, as it is called; one of them is that the State teaching competes with other teaching, and the other is that the State can offer rewards which privately-endowed bodies cannot. Those are two very different classes of objections. Would you be disposed to remove the second class of objections by throwing open State endowments to be won by persons taught at private institutions?—Yes, certainly. I am distinctly of opinion that in the encouragement of chemistry for the good of the industry of this country I should abolish any restriction about classes, that is to say, I should not limit it to artisans, but I should give encouragement and fair competition everywhere. I do not mean by that that I would pay money direct in the way of results, for the instruction of the middle classes, who I think can remunerate the teachers themselves enough; but the prizes which the State gives for the encouragement of chemistry, by way of scholarships for advanced attainments in chemistry, I should throw open upon the merits of the case to all classes of society.

122. Would you be disposed, then, to do this. Supposing there are three or four privately-endowed bodies in London, we will call them A., B., and C., should you be disposed to give the students of those privately endowed bodies a fair and equal share in all the endowments that are going, and let them keep

those endowments while they continue their studies at those same privately-endowed bodies?—Yes, provided the results were obtained.

123. So that you would be disposed to give a fair share of the scholarships, which would be given by the Government, to those private bodies?—I should not give the scholarships definitely to A. B. and C. D. colleges, some to A. B. and some to C. D., but as the process by which science should be encouraged I should say that there should be so many scholarships for acquiring perhaps two or three sciences, say chemistry, natural history, physics, and perhaps some others; that there should be so many scholarships created, and that those scholarships should be openly competed for over the whole of the United Kingdom; that if College A. were teaching those sciences, and had men of mark as the professors of those sciences, and the B. institution in like manner did the same, and C. also, I should then say that those prizes should be held out to the places giving the instruction which it was desired should be obtained, and that the holders of those scholarships should be free to go to A. B. or C. D., as they might elect, and that the students should get some benefit of the scholarships, and the institution should get some benefit of the scholarships; but I would not assign a certain number of scholarships to A., some to B., some to C., and some to D.; I should leave the holding the scholarship at a given school, to be resolved by circumstances; in fact, I should encourage competition between A., B., C., and D.

124. One of the principal objects of the Commission is to inquire how the money given by the State in aid of science could be better distributed. I apprehend your present statement goes to show that the mode in which the distribution is made, might be better effected than at present?—Such is my opinion. I would not have those definite payments for the scholarships of universities and colleges. I am not sure whether there are any that go to Oxford and Cambridge, and perhaps I ought to except from them the payments for the examinations of the University of London, which is another matter altogether, the University of London not being a directly teaching institution, although there is an examiner of the University of London who gets, I apprehend, 300*l.* a year. Nevertheless, I should put that into a different class, but so far as direct endowment goes, say 200*l.* a year, to Edinburgh for teaching chemistry, I should, if I were quite free, and could do it without a great row, take that away from Edinburgh, and I should very much increase the whole of the sum to be paid for encouraging science, leaving Edinburgh to compete with Glasgow or London, or anywhere else, by getting scholarships. I think that would be an extremely good and self-acting system, and would get rid of all idea either of patronage or preference in one place or another, and would put all those places upon their mettle to do that which it is assumed is wanted so far as regards scholarships. There are other modes of encouraging science besides that.

125. Will you be good enough to state what the nature of those modes is?—I should think that if a place manifested its earnestness for having science taught (and we are speaking of science now as applied to industry), and if it came forward with land and with money for buildings, and the foundation of scholarships by the good people in the neighbourhood, I should think that a very fair case to receive public grants for buildings. I think, for instance, that Owens College coming forward as it is doing, with very large subscriptions in aid of industrial science, and feeling the necessity for having something more, the State being assured that Owens' College is doing what is right, it is fairly entitled to consideration, say for a building grant. I do not know whether University College ever got a building grant, but if University College wanted to promote industrial sciences, and wanted some aid in the way of buildings, and engaged to follow the conditions, and submit itself to the disagreeables of Government connexion, I am quite clear that it ought to have the



money, assuming that public opinion and the Legislature and the financial authorities are all convinced that it will be for the good of the industrial interest of this country, to have certain things more actively promoted than they are at the present time by independent action.

126. I apprehend that your general principle is that you would not keep State competition, but you would widen State help?—I would widen State help, and I would have no State competition.

127. In what sense do you use the word competition? Would you put down all bodies at present employed in teaching by the State, and abolish all regius chairs?—If I were free, I would translate all those regius chairs into scholarships. Supposing that a training school for science were established for training teachers, and supposing the public were allowed to come there upon the payment of high fees, it might be said that there was a competition with King's College or with University College. I should rather get over that difficulty by not allowing any of those public scholarships to be taken at the training college. I should make them as public scholarships applicable solely to institutions of a private character which were doing the work that we wanted, so that I can conceive that there really would be no competition at all; there would rather be good fellowship and aid wherever it was afforded, and the State would do that one thing which could not be done otherwise.

128. You mean that all students in your training college would be persons who had, so to speak, passed out of those private bodies?—Yes.

129. Carrying out your principle fully, you would abolish all those aids in the way of grants of money and all regius chairs in the kingdom?—Theoretically I would. I do not see upon what principle you can give 400*l.* a year to Glasgow, and refuse it to Owens' College at Manchester; or, as has recently been done, you give 120,000*l.* for buildings in Glasgow, and nothing to Manchester. That seems to me odious.

130. Do you think that persons competent to teach the higher branches of science can be expected to trust wholly to the returns from fees anywhere?—No.

131. How would you propose to get over that difficulty, unless you keep up your grants in some shape or other?—I think that you may do it by this process of scholarships.

132. But scholarships will not pay the professors?—A scholar does not pay the fees; but the Government will pay a given sum on behalf of the scholar, and I think it would be quite possible to give the scholarship and secure the professor a good income.

133. Simply out of the payments made by the Government paid scholars?—It would come materially in aid. Instead of paying 400*l.* at Glasgow in faith for the students that happen to be at Glasgow, I do not see any reason why Glasgow, if the professor be what he ought to be, should get at least 400*l.*, we will say, of State money for the scholars. Perhaps you would begin with a high payment and gradually get a somewhat lower one; but I cannot understand the principle, except by the pertinacity of the Scotch members, how 400*l.* was assigned for chemistry in Glasgow, and nothing to King's College, or to University College, or to Owens' College, or to a great number of other places.

134. But I understand you would, theoretically, at any rate, withdraw every description of help from the teaching of science everywhere, except that which results from the payment of students or for students?—It seems to me that it would work itself as a general principle, with fairness to the whole country, and better, as far as my lights go, than any other system. I daresay something better could be invented; but it has not occurred to me that there is a better system. Even with the case of Glasgow, where 400*l.* is devoted to chemistry, assuming for the moment that 20*l.* a year is to be paid for the instruction of a scholar in chemistry, without taking away its 400*l.*, and inter-

fering with its existing rights, I should make it an obligation on Glasgow to take 20 scholars to learn chemistry, which scholarships should be obtained by open competition, and I should couple that condition with the 400*l.* I should not have any hesitation about it.

135. In the higher branches of science, take the higher branches of mathematics and higher analysis for example, how could it be possible that a professor should ever have enough pupils, either paying or being paid for, to give him even bread and cheese?—That enters upon a question quite beyond my province. I am thinking only of teaching, where science is applied to industry. It also opens the question of whether it is the business of the State, without reference to the results at all, that is to say, without tangible and obvious results, to encourage certain good things which you cannot hope will ever be self-supporting; but that is quite another branch of the subject altogether. It may be right to have half a dozen bishops in mathematics, and really to pay them like other bishops for promulgating mathematics; but I have not applied my mind to that view of the subject.

136. I asked the question because the regius chairs account for a considerable amount of money which is spent by the State for science, and it comes completely within our inquiry to know whether the money which the State spends for science could be better applied, either by increasing the value of those regius chairs or by withdrawing the money altogether?—I have no doubt whatever that if public opinion desires that subjects should be endowed without reference to specific results, that is to say, tangible results, whenever that time comes they will be endowed; but I do not think that public opinion, as far as I understand it, is inclined in that direction at present. I certainly should have no hesitation in coupling the obligation to receive scholars with those regius endowments for science, and here perhaps applying the same principle to Oxford and Cambridge for its Latin and Greek, and I think that we should get some tangible result, and that the whole country should have the advantage by this competition. I do not think that there would be any grievance in asking the professor at Glasgow to receive 20 students in chemistry, and that he should be credited with 20*l.* a year for each.

137. By tangible result, you mean evidence that the student has learned something?—Yes.

138. You do not mean that he has learned something which shall be clearly shown to be of money value to him?—No; simply that that he has learned something.

139. Can you give the Commission any idea of what a science teacher under the department can earn by the system of examinations now current?—The most notable case, which we have often talked about, is that of Bristol, and there the teacher of science employs his day and his evening in teaching science; and we have got a list of the payments made during the past year, and I will take a few of the largest, those exceeding, we will say, 150*l.* a year. The first I come to is Alexander Bickerton. Mr. Bickerton is a great organiser. He has taken certificates in a number of subjects; but he has great aptitude for organising, and he has organised a number of schools throughout the neighbourhood of the metropolis, at Wandsworth, Chelsea, Knightsbridge, Nine Elms, and Hampton. At Chelsea, to which he has paid the greatest part of his personal attention, his payments were 233*l.*; that is to say, he was in a broad way credited with 233*l.*, but under a drastic rule which we have, when the payments exceed a certain amount, they are reduced, and thus Mr. Bickerton received last year only 159*l.* The next case is the Bristol one, where the payments on behalf of science are 653*l.*, and the teachers are T. Coomber, E. C. Plant, and J. Welsh, but practically Mr. Coomber is the director there, and I should think that out of that he certainly gets more than 300*l.*; but that is a case where the teacher employs his day time as well as his night.

H. Cole, Esq.,  
C.B.

14 June 1870.



H. Cole, Esq.,  
C.B.  
14 June 1870.

I observe there is a man at Birmingham, W. T. Bulpitt, who is entitled to receive, and who seems to have received 236*l.* 10*s.* Then, at St. Mark's College, Chelsea, where they teach a number of sciences, they were entitled to receive 230*l.* I have nearly exhausted those above 150*l.* George Roberts, at the Battersea Training College, received 155*l.* W. T. Rowden, who, I believe, was altogether bred by this system, and who is a clever and promising man in the colliery district, received 205*l.*

140. (*Mr. Samuelson.*) That is quite new, is it not?—It is within two years; he was employed by the Coal Owners' Association. Edward Tomkins, in the district of Ravenstall, Bacup, Rochdale, Patricroft, and Openshaw, I see, received 209*l.* I do not find in Scotland that anybody has earned as much as that; nor, indeed, I think, in Ireland, where the payments are very numerous, but not so large.

141. (*Professor Huxley.*) I suppose it would be safe to say that an able and energetic man would be able to earn 250*l.*, giving his whole time to it?—I should say that any man teaching in the daytime, and in a populous place, and where his school is not charged with rent, would certainly make 250*l.* without great difficulty, even with our present system.

142. There is no check at present, is there, upon any person in any place, or any number of persons, sending up people to be examined?—None whatever.

143. So that it is quite possible that the amount of money to be paid in any given year may rise to almost any given amount?—Yes: the estimates, according to the present system, must, I think, largely increase. They were largely increasing last year, and the department was a little alarmed at the penury of the nation, and they took some measures to endeavour to keep the payments under control. That produced a horrid outcry, and we were called miscreants and breakers of faith, and all that sort of thing; it was a little hard, but still the aggregate payment now has become a large one.

144. What is the amount upon examinations?—The payment upon results to teachers is estimated at 24,000*l.*, and we are alarmed at that amount.

145. As a matter of fact, not to use too strong phraseology, the practice was rather sharp last year, was it not, with regard to the pledges given to teachers before?—It was rather too prompt. I think that we were open to censure for being too late with the promulgation. We ought certainly to have announced the intention three months before it was announced, and then I think there would have been neither sharpness nor breach of faith; but it was undoubtedly open to the observation that in the midst of the session we made changes: but the remonstrances were too strong for us and we had to retreat.

146. Could you give the Commission a rough notion of the rate at which the number of persons examined each year has been increasing for the last two or three years, I mean for examinations in science only?—I think I have already given that answer. The progress of the science schools since the passing of the general science minute, June 1859, is shown in a table appended to Captain Donnelly's memorandum, by which it appears that in the year 1860 there were nine schools and 500 under instruction, in 1870 810 schools and 34,000 under instruction.

147. It has increased we will say eighteen-fold since 1852?—Yes.

148. (*Chairman.*) The increase has been going on more rapidly, has it not, during the last few years than before?—Yes, it is going on progressively.

149. (*Professor Huxley.*) The increase is 50 per cent. during the last 12 months, so that it is quite possible that the vote may rise to 40,000*l.*, 50,000*l.*, 80,000*l.*, or more, in the course of the next 10 years?—Quite possible by this system of payment upon result, especially in night classes; it has not yet touched the day classes much.

150. I presume that the only guarantee that you have that the money is spent properly, is the fact of the examiners doing their duty; you have absolutely

nothing else in fact?—No other, and the inspection, of course. I do not think myself that there is scarcely any amount of abuse worth noticing.

151. Could you give the Commission a notion of the general per-centage of rejections last year or the year before, or what would be the average of rejections?—Last year out of 19,000 examined, 7,000 were failures, or rather more than one-third; that is of course the failures to come up to the standard of the examiners.

152. Would there be any objection to put in a document showing the instructions to the examiners and the principles upon which the examination is conducted?—None at all. (See Appendix III.) It would be interesting to put in this table of the number of students under instructions, the number of papers worked, and the amount claimed in each subject, on the examinations of May 1869. For instance, the subject upon which the greatest amount of State money was paid for results, was physical geography, 2,610*l.*; the next subject was practical plane and solid geometry, which was 2,195*l.*; the next largest subject was magnetism and electricity, 1,941*l.*; and the next, machine construction and drawing, 1,861*l.*; the next large subject was animal physiology, 1,539*l.*; then elementary mathematics, 1,462*l.*; inorganic chemistry, 1,482*l.*; and the other subjects smaller sums.

153. Does it come under your knowledge that any considerable number of candidates are rejected for copying and such small crimes?—No, a small number.

154. Do you imagine that your system of conducting examinations practically prevents that?—I think it does. It is open, of course, to possibility; but I do not think it happens to any extent, and I think that we almost always find it out by one way or another; either somebody peaches, or the answers are so identical that an inquiry is provoked, and the thing is found out. It would seem much more difficult in the art examination to find out unfair conduct, but we really do find it out. For instance, supposing that the bottle on this table is given as the subject for examination, our examiners really do find out whether a school has taken an unfair advantage in a private examination of that bottle. We had a remarkable case this year, where there was reason to think that some unfair advantages had been taken; and it turned out that the secretary had disclosed to the school the object which they would be called upon to draw, and they had then practised it some time before the examination, and it really was found out by the evidences of the drawings themselves, which is more difficult than the science papers.

155. Upon that account do you consider that if all the inspectors and the examiners did their duty the money would be fairly paid?—I have no doubt about it.

156. There is another point upon which I think the examiners have made representations once or twice; it is a difficulty which arises with all examinations that I ever was connected with, and it has been adverted to by Mr. Samuelson, and that is the normal and regular tendency to cram the students for examination. There have been representations made to the department upon that subject, have there not?—Not a great many. I think it has been more outside talk than anything else.

157. I think there is a certain tendency on the part of some of the teachers, if I may use a familiar phrase, "to teach for the pot"?—Yes; there no doubt is that tendency.

158. That is to say, to get a number of very small boys, and cram them like turkeys, with just what they can put out again when the examiner asks them questions?—Yes.

159. Do you think that that has been on the increase or the decrease, since the commencement of the whole system?—I do not think that there has been any increase myself. I should be inclined to think, speaking generally, that there had been rather a decrease.

160. I presume that that is a matter which may be



dealt with by the examiners if they look carefully into their work?—I think that new teachers may commence that system, but they find after a little experience that it does not answer. There are always cropping up some new teachers everywhere who bring forward such things.

161. Do not cases of this kind sometimes happen, that 70 or 80 sets of papers are sent from one school, and perhaps 75 out of that number are plucked for that simple fault?—Yes, those things have happened.

162. But that is on the decrease, is it not?—Yes; it is sufficiently checked, I think.

163. Do you think that the old system of an examination for teachers was a very great check upon that?—Yes, but only so far as having proof of a teacher's own knowledge.

164. Under the old regulations the teachers before they were allowed to teach were called up and had to pass a special examination of their own, and the result of that was that they were at any rate seen to be competent to teach, it being in the main the incompetent persons who try those tricks?—I have reason to think that some of the worst cases of cramming occurred under teachers who were supposed to have been highly skilled in teaching.

165. Do you think that any good has resulted from giving the teachers special instruction how to teach physical science?—I have heard it said that the examinations this year have proved the advantage of that little instruction that was given last year, and that confirms me in the view that it would certainly be desirable on some system or another to improve the teaching power of masters. It is obvious in a case like that where the instruction ought not to be by book instruction, but somewhat by manual dexterity, and possessing really a knowledge of what can be done, that you can hardly impart that knowledge to teachers excepting by demonstration, it is not to be done by books; the same thing applies to chemistry, and no doubt to other subjects.

166. What proportion of all the persons who are recognised by the department as teachers came up to this special instruction last year?—There were 253 who came up to those lectures, and the number of teachers giving instruction at the present time is 957. You will observe that those came up only for certain subjects.

167. You pay their expenses up to town, do you not?—Yes, and we give them their maintenance allowance during the week.

168. What evidence do you require that they have profited by that stay, if any?—They had to take notes and to make a report, and the lecturer examined into the result of their coming up. They were not allowed to come up to London and amuse themselves. They had to attend every day.

169. May I ask what would happen supposing you had reason to believe that an examiner did not do his duty properly, because that is the most important part of the whole system in relation to the distribution of public money?—I think the simple process would be that he would not be asked to examine again, and such cases have occurred. Of course they are rare, but there are occasions when the department has been of opinion that an examination has not been quite satisfactory. I do not say whether in science or art, but in such cases the examiner simply has not been asked to do the work again.

170. Then the examinership is not a permanent office, but one which is held at the request of the department for a year?—It is like almost all the work of the department, it is done by piece work and not a permanent arrangement.

171. (*Sir J. Kay-Shuttleworth.*) I think I understand you to say that the teaching in science of the country is at present chiefly conducted in evening schools?—Yes, the teaching to artisans in evening classes; I am under that impression.

172. Are you aware to what extent it is conducted in day schools?—I think we can give in a return without difficulty, showing where the instruction is

imparted by day teaching. At page 78 of the 16th Report, there is an "Analysis of the science schools" and classes in connection with the Science and Art "Department, made up to April 1869," which gives the information which the honourable Commissioner desires—"Institutions in which boys are taught, "having day or day and evening classes in science, "78, and the number of individual students, 5,129." "Training colleges having science classes, 15; and "the number of students, 824. Institutions in "operation as science and art schools, but having "evening classes only in science, 12; and 615 students. "National school premises used for evening science "classes"—we can do nothing in the daytime there—"206; and 5,745 students. Evening science classes, "taught in buildings of a miscellaneous character, 56; "and 1,666 students. Navigation schools, 7; and "1,150 students. Science classes in mechanics, "literary and other institutions of a similar character, "143; and 6,494 students."

173. So that out of 516 schools or classes, 78 are taught in the day time?—According to that table that is so.

174. I understand that the occupations of the teachers who are employed in teaching those classes are various; they are not solely employed in teaching the classes?—Yes, that is so.

175. Are the majority of them teachers of day schools?—I think the tendency lately has been to increase the number of teachers of day schools. At the beginning I think it was not so; in fact the Education Department years ago discouraged the teachers doing anything but attending to primary education, but that restriction has of late years been somewhat ameliorated.

176. It has been altogether withdrawn, has it not?—I am not sure whether there is not a remnant of it. They cannot teach science during the day in the day schools, but in the evenings they can. There was a restriction on account of their having pupil teachers at one time.

177. Is there any remaining restriction upon the teacher of a day school holding an evening school for science or for any other purpose?—Not in England.

178. To the extent, therefore, to which certificated masters in charge of day schools are employed, the instruction in science in the evening has to follow somewhat like five hours of instruction of the day schools and one hour and a half of their pupil teachers?—Yes, it is hard work, certainly.

179. Whilst on the one hand there would obviously be a great advantage that a certificated master should be employed, inasmuch as he would have not merely sound elementary instruction, but a knowledge of method, is it not clear that inasmuch as he would be employed five hours in the instruction of his day school, and ought to be employed an hour and a half in the instruction of his pupil teachers, it would be a disadvantage to the science school that he should come to the instruction of that school after six and a half hours of previous instruction?—Yes.

180. It is not strictly within the limits of the proper inquiry to be made of yourself, but may you not be incidentally aware that certain of those certificated masters are likewise employed in the instruction of ordinary evening schools?—I think most likely.

181. If, therefore, there should be superadded to the work which I have described, the instruction of an ordinary evening school, antecedent to the science school, that would add to the labour of such employment?—Yes.

182. And to the fatigue of the master?—Yes, certainly.

183. If I were, therefore, to take into account the fact that a very considerable proportion of those teachers are certificated masters so employed, is it an improper inference to regard the present system as transient and temporary?—I have no doubt that it is only a transitional system, somewhat like making bricks without straw. Not apologetically, but I think it right to say that really Lord Salisbury, like the

H. Cole, Esq.,  
C.B.

14 June 1870.



H. Cole, Esq.,  
C.B.

14 June 1870.

Egyptians, put us under a constraint, telling us to do something for science. We had to grope in the best way we could, we were not received with open arms by the primary division at all, we had no teachers, we had no diagrams, in fact we had just to do the best we could; and I think that some good has been done, and I think a great deal more good can be done.

184. Turning from the existing system to that which it is proposed to substitute for it, as I understand, namely, the establishment of a training college for the instruction of teachers, have you formed any conception of the period, that is to say, the number of years during which it would be desirable to train such teachers at such a college?—With all submission I do not look upon a training college for teachers as a substitute for the present system. I look upon it as supplementing somewhat the deficiency of the present system, and providing the means for increased instruction which could be given at other times than in the evening. I think that the present system is likely to go on, with modifications, for a long time, that is to say, giving instruction to persons in the evening who are willing to come for it. A great part of those who do come now, under no circumstances would be able to come in the daytime. I look to the creation of science teachers in greater numbers than exist now and more competent teachers than exist now as being likely to tend to the creation of day instruction in science, and particularly in centres of industry where at present there are no schools, or but few schools, and still fewer teachers. At present, if any magic wand were held up over England and it was said that there should be 100 day schools in substitution say of the effete grammar schools, you would have no teachers, or you would hardly have competent teachers to carry instruction into every part, and until you have got your teachers you cannot carry, in my opinion, out a system of general instruction in science.

185. Not to revert to my question for a moment, but going back to what we have previously been discussing, is it not a clear and absolute necessity that a system which employs for the majority of its teachers certificated masters, who have charge of day schools and often likewise of elementary evening schools and the instruction of pupil teachers, and superadds to that labour the charge of science schools, should be regarded as simply transient and temporary?—Certainly.

186. Seeing that it is simply transient and temporary, the question that I put was, What is to be the period of instruction in a training college intended for the production of a superior class of science teachers?—Hitherto the world has made use of the best material at hand for getting any science instruction; getting a better set of teachers, and relieving the over-lagged teacher of the elementary school from the duties which he now performs, and perhaps helping him in the daytime a little, so I think that science teachers are wanted and would be useful.

187. I want to know how long would be the period of training for an individual?—I should think that, taking some of the best of our certificated teachers, and bringing them up to a centre where they would learn all the best modes of teaching, they would get a good deal of power in a year.

188. But if they were not certificated teachers, how long would the period be?—Then I think they must come to us certificated.

189. They must come to the Science Training College with the ordinary certificate of primary instruction in an ordinary training college, and then they would require a year's further instruction in science?—Yes; more than that. I should say that before coming to any central place, they should bring up a certificate of a high grade, such as we give now by the paper examination, of so much competency as is proved by the paper examination. It is indispensable that they should come up rather high.

190. Then it would be the intention to employ those teachers not as being, as at present teachers to a considerable extent are, in charge of elementary day schools and of pupil-teacher and evening school in-

struction, but as in charge of scientific instruction either in day or evening schools without having charge of day schools?—Yes; a class of secondary-instruction teachers. I think that that is a matter wholly unprovided for at the present time.

191. Has any estimate been made of the annual cost of the training of a pupil in London at the proposed Scientific Training College?—I do not apprehend that the cost need very much over a large number exceed the cost of a student at St. Mark's. I should think that about 50*l.* a year would do a great deal.

192. At present I believe very few building grants have been made for the erection of scientific day schools?—Very few.

193. In prospect of the training of such scientific teachers in the proposed college, I apprehend that the department has in view the building of scientific day schools in the country?—I should hope so, but we have nothing in view; we are only prepared to respond to the public demand governed by the views of the Treasury.

194. But it seems to follow that if there is a teacher there should be a sphere of action?—Yes.

195. Consequently if the sphere of action is to differ from that which at present exists, it would seem to be of necessity that there should be either a scientific evening or day school, and buildings where there are not such buildings as those of the superior mechanics' institutions?—Certainly, the present system has been to lay the foundations for such spheres of action.

196. Has not one merit of the existing system been its very wide diffusion through humble spheres of action, and its availing itself of any, even the very humblest, means in point of buildings and local appliances?—Yes.

197. And it has had to struggle against the difficulties to which I have already pointed of employing over-worked teachers in extra hours of labour?—Yes.

198. I understand your idea to be this, that you would desire to create a much higher class of teachers, and that they should not be over-worked, that they should have an opportunity of being employed in the day as well as in the evening, and that they should not, as at present, have other scholastic duties which are liable to be consequently ill-performed?—Certainly, I indulge in a dream that all populous places will have several grades of schools; that you will have an infant school, and a school for elementary instruction, and that you will have then a secondary instruction school to which the best children will be drafted, and in those schools I think you will want a good many science teachers. Such organizations are growing. There is the case of Faversham, which is a notable one, where the people, having had the misfortune of a large endowment, and having pauperized the neighbourhood through its means, and brought all the riff-raff of the county to come and live in and near Faversham, they awakened all of a sudden to the conviction that they could do better with their money than give it away to the poor of Faversham, and they reorganized all their educational establishments; church and dissent seemed to have sunk all their differences; they have one very large infant school, they have two other schools of a primary character; they have another branch to which boys are drafted, and some of them supported, that is to say, they do not pay fees, and in all those divisions the whole of the people of the district seem to unite and get advantages. The respectable tradesmen send their children to the upper school. They send them in the first instance to the primary school, and then the children go on to the other school; thus they have in Faversham those schools which are worth anybody's while to visit. They have some old-fashioned notions, but still they have this organization of drafting the children from one grade to another. The only link in the chain that at present is not as right as it should be, is the grammar school; they have an old Edward



the Sixth's Grammar School which wants putting in order, and out of which they get little good at present. I look forward to a time when populous places will have those grades of schools, and in the last grade but one, and in the last grade of the schools, meaning the highest, I think those science teachers will be very much wanted.

199. One advantage of the evening science school has obviously been that a youth might pursue his practice of some department of industry in the daytime, and acquire theoretical instruction connected with that department of industry in the evening—as for example, he might be working in a colour shop or print works in the daytime, and he might attend a chemistry class in the evening—do you consider that the combination of practical instruction in art when combined with theoretical instruction in science important or otherwise?—Very important. I cannot doubt that a carpenter who knows a little of geometry, and who is able to form theoretically an oval accurately on paper, would be all the better carpenter for having that knowledge. At the same time I am bound to say that I think students in the evening classes frequently go in for a kind of relaxation. If they take up with botany or zoology, or any branch of natural history, it is rather a relaxation from their daily work, although the numbers that I have read show that a great many certainly go in who have practical objects in view.

200. I do not mean in the slightest degree to under-rate the importance of mental training, even when it is pursued for the object of amusement, but looking to the industrial progress of the country, and to the idea which has possessed many minds that that progress might be greatly promoted by the union of practice with a knowledge of scientific theory, is not that combination of the employment in the workshop with theoretic instruction important?—Most important. It was advocated by Adam Smith 100 years ago, who said that the state would do well to encourage the teaching of elementary and geometrical drawing by giving prizes amongst the people, and yet within my recollection a minute of the Board of Trade was nearly passed (it was not passed), saying that it was no part of the business of the State to help carpenters to draw at all.

201. Supposing that a training college for the education of teachers of science should be developed at South Kensington, would it be desirable or not that besides theoretic scientific instruction, the application of that instruction to the arts and industry of the country should be taught in that college?—My own opinion is that such special application ought not to be taught there, that having given a general instruction, and qualified the teachers to impart it as much as may be, you should leave them and the various industries to settle any further development according to their wants. I do not mean that in looking to the establishment of a central training college you are to supersede perhaps some special developments of it in the third year's instruction, say in respect either of mining or naval architecture; perhaps there may be some other subjects, and I should not like, in seeming to advocate the establishment of a training college, to be thought to desire to extinguish the School of Mines, or any of those specialities. I would rather like to see them treated as they are done in the College of Science in Dublin, made a special business for a third year's course of instruction. Whether a teacher would take up with a third year's course, say for mining, or not, I do not know. I do not think that many would, although some might, and I would not prevent them, but I can hardly contemplate that they would take up much more than the generalities.

202. Is it not apparent that the School of Mines was originally established with an idea that such a combination of theoretic and practical instruction was desirable?—I apprehend so certainly.

203. Does not that idea also govern the establish-

ment of the School of Naval Architecture and Engineering?—Yes, certainly.

204. Might I not also ask whether the same idea has not extended to some departments of the School of Art?—It might seem so, but I do not think it can be said to have extended much. We have had two or three experiments during the period of the existence of the school in trying to apply drawing and painting and modelling to specific industries, but I confess that the ways of the world have beaten us altogether; we have had no success.

205. Supposing a school for the training of teachers were established at South Kensington, am I not right in conceiving that there might be two motives for its existence, the one that a purely theoretic school of science should be attended by a special class of students intended hereafter to teach the working classes and artisans throughout the country, and the other that it should give instruction in science in its application to industry?—I think it might properly have those two functions, and ought to have them. In the paper which I submitted to Mr. Samuelson's committee, at page 392, after suggesting what might take place in the first and second years, I laid down the theory that in the third year there should be instruction in mining, geology, with demonstrations of palæontology, mineralogy, mining, and assaying, those subjects being taught having special reference to mining. In division B, I assume somebody to have gone through the first two years, and in that division if it were thought expedient he might take up those branches of science that have reference to agriculture, namely, geology, agricultural science, and land surveying. In division C, he might take up engineering, that is to say, mechanism, machinery, mechanical drawing, and surveying, and in division D, manufactures, he might take up mechanism, applied mechanics, and physics, and applied chemistry. Those divisions very much follow the division that Lord Rosse's Commission recommended for the Science College at Dublin. In framing them I had in my mind that a manufacturer, who desired that his son should get what precise knowledge he could in any one of those divisions, would here have some means of obtaining it. He might come, of course, with the first two years prepared at the general colleges throughout the country, but the assumption was that it would be possible that he could get more precise knowledge in the third year than he would obtain elsewhere. I thought that for different purposes, just as you go through a theological course, or a legal course, or a medical course, you would be able to bring together such an amount of theory as would have all those different developments for the more particular promotion of each beyond what was being done elsewhere throughout the country.

206. Such combined practical elementary instruction as is now in its first stage in the evening schools taught by science masters throughout the country is clearly in harmony, is it not, with the general idea which Sir Joseph Whitworth has put forth in respect to the application of his scholarships and endowments?—Entirely so.

207. I conceive, for example, that when Sir Joseph Whitworth requires manual skill in certain departments of mechanical instruction, together with instruction in mechanics, and certain departments of mathematics, he provides for that combination of scientific and practical instruction which is in a humbler degree fulfilled by the evening schools of the country?—Yes.

208. Would it not therefore be extremely desirable that the combination of the practical and theoretic should be provided for both from the fountain head, the training college, and in the local school?—Certainly, I think so.

209. (*Professor Stokes.*) Do the examiners send in reports to the department, or do they merely return the number of marks which the different students gave?—Both, and further, sometimes special subjects are referred to the examiners upon which they report, special subjects which seem to arise out of the new circumstances of the examination.

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C.B.

14 June 1870.



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C.B.  
14 June 1870.

210. Are the reports published in any way?—  
Yes, generally, if not always.

211. Are any of the examination papers preserved as specimens, say a few of the best and a few of the average?—Yes; but they are not preserved for a great length of time. You could have before you, I presume, if you desired it, specimens of the last year's examination, or you could have the whole of them, they are kept for a year.

212. You stated that the body of examiners was a fluctuating body; are there any means adopted for insuring as far as possible uniformity in the standard of examination?—It has been usually the practice for the examiners to meet together, and to confer over any points of that kind.

213. Then the examiners are not as a general rule changed from year to year?—As a general rule they are not, certainly.

214. (*Dr. Miller.*) I observe in the report of the Science and Art Department there is a series of examinations, 23 in number, some of which are held in duplicate by the same gentleman?—Yes.

215. Does this list include the whole number of examiners of the department?—Yes.

216. Do these gentlemen examine in every part of the kingdom, or do they examine in London only?—Only in London. The system is that the papers are sent out on a given day, they are opened in the presence of the local committee, three of whom ought to be present at the opening of the papers; the papers are given out to the students who are assembled in the room, and who sit apart according to rule; three or four hours, according to the nature of the papers, are given for the working of the papers; the papers are then collected, and are sealed up by the committee, and are put into the post, and if anything happens to prevent it the committee are bound to telegraph, and if the papers do not come up we telegraph to know why they do not; so that practically those papers, say on chemistry, are given out at one moment to all the schools and classes throughout the country at a given hour; they are all working these papers at the same time, and the papers all come up by post the next day. The papers then are handed over to the different examiners, and according to the number of papers the examiner is responsible for making his arrangements and examination. Where the subjects become large, he has assistance, and he adopts his own method of examining and passing those papers; and as soon as possible he returns those papers with any special observations or report that he thinks necessary. A number of clerks and people at this time of the year are busily engaged in making up the results. Everything is done by numbers; nobody knows anything about the people at all; and the results, after some weeks' labour, are tabulated and brought out.

217. No *riâà voce* examination then is practised?—None at all: but the rules of the department reserve the power of having any *riâà voce* examination, where the department thinks it necessary to have it.

218. Is there any special care taken to prevent the possibility of the questions being made known beforehand, is there any check for the prevention of proofs getting out, because that has been found in many examinations to be a matter of considerable difficulty?—We have tried to organise a system by which it would be extremely difficult for any paper to be made known before it goes out officially to the local committee. I believe Captain Donnelly has arranged with special printers, so that if there were any abuse in the early publication of the papers it could be traced to the offender. The composition and the printing on the press is all done in one room by a few people; the proofs are not scattered through the printing office in the usual way.

219. A difficulty usually arises with the proofs. It has been found so in the University of London, and it has been found necessary to take special precautions?—We have never had any cases where we have had

reason to suspect any fraud, but of course such a thing is possible.

220. As this subject has been discussed in some detail previously, is it proposed that this training college shall be limited entirely to those who are to follow the profession of teachers of science?—No.

221. Then the college would, in fact, be a general college for instruction in science?—To a certain extent. Perhaps, broadly speaking, I should say yes, just as the Art Training School admits the public, so long as there is room on the premises.

222. Then, as I understand, it would be a school in competition with other similar institutions in the country?—Yes, to a certain extent it would.

223. To what extent?—To the extent that it would teach chemistry and would teach physics under certain rules, and perhaps strict rules; I do not mean strict in a scientific point of view, but people would not be able to come and go quite as they liked on the payment of high fees.

224. A person would present himself, would he not, to that college without any matriculation, he would enter the particular courses, and he would be enabled to be trained in any branch of science at the expense of the Government?—Not at the expense of the Government at all, but at his own expense.

225. True; but the Government would provide salaries for the professors and provide the means of teaching, libraries, museums, and all the apparatus necessary?—That would be essentially on behalf of the teachers, and there being space, as there would necessarily be, it would be profitable and economical to allow the public according to the rules, to have the advantage of them. Whether the public should come in without qualification is a doubtful point. My impression is that they would come qualified.

226. Supposing that the Government were to make such a school as that, do you see any impropriety or difficulty in the Government supplying to existing institutions similar facilities?—I think I have expressed generally my notion of the most wholesome way of encouraging the sciences (I am not thinking of the institutions, but of encouraging science throughout the country) would be by scholarships gained in open competition, and I have said that the scholarships might be held at recognised institutions.

227. But if the Government, as they do now, remit the fees, that would be giving double scholarships to those gentlemen at those institutions who followed a particular branch of study in their own school?—No. At the State institution, by whatever name it may be called, a certain number of people would be paid for coming and be maintained there—that is as teachers—a certain other number would come with more or less competency, rather more than less, and who possibly might be admitted without payment of fees, it being understood that they are going to be teachers, and then a third class would come, the public at large, who clearly would get some good out of the institution, and get something there which they could not get at other places, and for which they would pay high fees. We have that system in operation at the School of Naval Architecture; a certain number of students are sent from the Admiralty for the express purpose of being trained into being designers for the ships of the Admiralty, and that of course upon the assumption that that instruction is not to be found precisely and adequately elsewhere. In addition to that the public are allowed to come in upon payment of rather stiff fees, and the school is made up about half and half of Admiralty students and private people, who come for that instruction. Some indeed come from Russia, and some from Prussia, and some from other parts of Europe. I fancy that the same kind of analogy might prevail in this proposed State Science institution.

228. (*Chairman.*) Then the State doubly assists those persons?—You may call it a scholarship worth 70*l.* a year.

229. Is it not a scholarship worth 70*l.* a year if they attend those particular State institutions, but a scholarship worth 50*l.* a year if they attend any



other?—That is the existing thing, but that is not what I am proposing.

230. (*Dr. Miller.*) You think that that presses unduly upon other institutions, do you not?—I think it is quite fair that the State, having given a positive salary to a professor, should say to him, "As part of the bargain between us, you shall take so many scholars without fees," but of course that would not apply to outside institutions, where they give no salary, and where you would give a scholarship in a way that would pay the fees, either directly from the State or through the students.

231. I do not question the propriety of remitting the fees, but I ask you whether the present system does not, in your judgment, give a double advantage to a student in case he goes to such an institution?—I think the present system, of course, is a sort of monopoly for two or three State institutions, but I have already said that in the interests of science I think that the monopoly might be got rid of, and the scholarships might be held at all qualified places.

232. Supposing that scholarships are only given at those institutions which at present receive Government aid, how do you propose to meet the case where heavy expenses are incurred in giving instruction as, for example, in natural philosophy and in chemistry, in which the expenses of the laboratory and the apparatus have to be kept up, as I understand the proposition which was made just now by yourself, you consider that the payment of a certain fee to a professor would be adequate to the payment which he now receives, provided only he obtains a sufficient number of students. Have you ever considered whether one of the modes in which the State might assist in the progress of instruction in science might be to increase the power of teaching by increasing museum facilities and also apparatus?—Yes, certainly, I should be glad to see that. I should be glad to see grants made to those qualified places; I mean grants in aid of specific things, not grants of money.

233. You expressed yourself, as I understood, solely in favour of science scholarships?—I really meant afterwards to advocate rather building grants, and laboratories, and apparatus, and diagrams. Let me say this, that it has not yet been considered in the broader sense of public policy to encourage science, independent of classes. You encourage chemistry for the benefit nominally of artisans. You have some difficulty in defining what you mean, and who are artisans or not, and you have given an accidental grant to Glasgow. It seems to me that the wants of the country, and public opinion are beginning to require that you shall widen your basis upon some kind of general principle, and that chemistry, for instance, for the good of your industry is to be encouraged in a Catholic spirit generally. Of course it becomes a question of minute detail and consideration how that shall be done, but the State never yet has recognised the principle, excepting by those accidental grants to Glasgow, that the middle classes are to participate in the advantages of this chemical knowledge, and excepting that they allow prizes to be given in science examinations. It seems to me that that point is the cardinal principle which is to be really pronounced upon. Are you going to encourage chemistry for the good of chemistry, and for the benefit of the industry of the country, without reference to the various classes of people who are to take advantage of it? That has never been pronounced upon as a broad principle.

234. (*Marquis of Lansdowne.*) I understood you to say that the remuneration of the teachers was at present a pure system of payment on results, and therefore no preliminary examination of them is required?—Not quite so broad as that. A teacher is bound to have come up to one of our examinations and to have passed in the first or second class in the advanced stage at that examination, and having done that, which of course proves that he has got an elementary knowledge as far as the paper proof goes, he is able to start himself as a teacher whenever he pleases.

235. Under such a central system as has been shadowed forth to-day, there would be a training and an examination before a teacher was allowed to enter upon his duties?—Yes, certainly; and probably one more drastic than the mere paper examination that comes now. You might conceive that a number of persons who desired to earn their living as teachers would send up their names, having qualified in those paper examinations, and then you might pass them, and properly pass them, because they would be a limited number through another competitive examination.

236. (*Chairman.*) Are the examiners appointed directly by your department?—Yes, by the Lord President.

237. Does he take the advice of the officers of the department?—I do not know that there is any objection to my telling you the exact process. The Lord President takes the best advice he can for getting the best men; he has the final responsibility of naming A, B, C, and D, as the officers of the year to act as examiners.

238. Is it the usual practice for the examiners to go on for several years together?—Yes, I think so. Some have been from the beginning, and others have only been a short time. For instance, Colonel Wray, R.E., for building and construction, is the instructor in those subjects at Chatham; he came for the first time this year. Dr. Frankland succeeded Dr. Hofmann. Professor Hirst is a comparatively new appointment, and Professor Goodeve is a comparatively new appointment. Some others have been from the beginning. Dr. Percy has been from the beginning, and I think Mr. Smyth from the beginning. I should say that we have rather a difficulty in keeping the best examiners. The Department has rather had to persuade them to continue the duty than otherwise.

239. Is the remuneration of all the examiners the same?—It depends upon the number of papers; there is a fixed moderate fee. We had better perhaps put in the minute upon that subject if the Commission desire to have it. (See Appendix IV.)

240. By way of summary I should like to ask you whether I correctly understand your views with respect to Government aid to science to be these, that if you had your own way you would like to confine it entirely to granting scholarships, to assistance towards buildings, to providing in certain cases apparatus or conveniences of that kind, and further to the establishment of a training college for teachers?—Yes. A training college having also a development into such divisions as I have mentioned, and being open to the general public.

241. Do you contemplate the continuance of the School of Mines as a special training college?—Yes, as a division of the great training college.

242. At present do you think that if a training college such as you contemplate were established there would be an adequate sphere for the employment of the teachers trained in that college?—I have not the slightest doubt, and all experience hitherto of the Art School shows, that we cannot train teachers to a high point to outrun the public demand.

243. I suppose, generally speaking, there would not be a demand for teachers of that description except in places of considerable size?—I think it is possible to concentrate a secondary school wherever there are 10,000 people.

244. That of course would require a very large number of teachers?—I think that any locality that awakened up to the sense of education, and desired to make the most effectual and efficient arrangements for teaching, without reference to isms, would have a secondary school that would employ one or more teachers of science.

245. Have you at all formed any notion in your own mind to what extent you would establish scholarships; supposing that they were 20*l.* apiece, what number do you think would be adequate sufficiently to encourage science according to your ideas?—I would propose three forms of scholarship, which would be open to general competition. First, a

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14 June 1870.



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14 June 1870.

scholarship of, say 70*l.* per annum, with a sum for paying fees; second, a scholarship of, say 50*l.* per annum, with a sum for paying fees; and thirdly, a sum for paying fees alone. This last would, as far as the student was concerned, only amount to a free studentship. The student or scholar should elect from a certain number of approved institutions which he will hold the scholarship at. In order to bring existing endowments by the State into harmony with the plan and to save existing rights, I would propose that for every, say, 20*l.* of State money the professor should receive a free student. For instance, I find that 200*l.* per annum is paid to the professor of chemistry in Edinburgh. For this 200*l.* per annum the professor of chemistry should be bound to receive 10 free students, these free studentships being open to competition. I need scarcely say that various details, such as payment of laboratory expenses, &c., would have to be arranged specially if this plan were adopted. I would also recommend that this plan should be followed with respect to the College of Science in Ireland, the School of Mines, &c., the number of free students which the Government had a right to send to be instructed being made to depend on the amount of salary paid to the professor. I find that about 3,100*l.* is paid to Scotch Universities to aid instruction in science. This would give about 150 or 160 free studentships. In England, with the exception of the University of London, which is a purely examining body, and the purely State institutions, such as the School of Mines, School of Naval Architecture, and College of Chemistry, I am not aware of any direct State aid being given towards scientific instruction in Colleges, and the like. There are several institutions such as Owens College, Manchester, University College, London, King's College, London, which might receive State aid, and be considered satisfactory places for holding the Government scholarships at. Supposing as an experiment to commence with, we had 30 scholarships of 70*l.* each, and 100 scholarships of 50*l.* each, and 150 free scholarships, as follows:

150 scholarships, putting the payment of fees	£
at 20 <i>l.</i> - - - - -	3,000
100 scholarships of 50 <i>l.</i> each - - - - -	5,000
30 scholarships of 70 <i>l.</i> each - - - - -	2,100
Payment of fees for the 50 <i>l.</i> and 70 <i>l.</i> scholars,	
say a total of 130 scholarships, at 20 <i>l.</i> each	2,600
Total - - - - -	£12,700

(Appendix V., p. 8.)

The witness withdrew.

Adjourned to to-morrow at 11 o'clock.

Of this 12,700*l.* it will be seen 5,600*l.* would go to the Professors and Institutions at which the scholarships were held—the proportions to each place being settled by a wholesome competition.

246. (*Mr. Samuelson.*) Could you put in an estimate of the actual cost of such a college as you propose side by side with the cost of the separate State teaching establishments?—Yes, I could form an estimate; but as it will take time to consider, I will prepare an answer for the appendix.

247. With reference to an answer which you gave to Sir James Shuttleworth, did I understand you correctly that you would contemplate setting your young men, who are to be trained as teachers, to work at the performance of manual labour as is done under Sir Joseph Whitworth's scholarships?—No.

248. (*Chairman.*) Do you think that a school for training teachers could be founded on such a system that it could be made attractive to young men wishing to become teachers without offering any special attractions to the public generally?—I think so; I think the public generally, who might desire to become mining engineers, would probably come to our institution for the third year, or possibly for the whole course. Those again who wished to take up with ship architecture would come as they do now, and I can conceive it possible that there might be such a development of chemistry applied to the arts as would cause it to be a special subject of attention; but I think the prime function of the place really should be the training of teachers as the thing which, in my opinion, is most wanted at the present time.

249. And in the degree in which it carries out that object it would be less a competing institution with other institutions for the advancement of science?—I say that I do not look upon any competition. I believe it is perfectly practicable to make those arrangements which would benefit the subjects of chemistry and physics, &c., in all institutions that are worthy to be encouraged without any competition by this proposed central institution.

250. But that is rather with regard to its practical effects. It might not be intended to be competing, but it might be practically so?—I think it would be possible to guard much against it; I certainly would not have the State scholarships taken in the State institution; they should be really for the encouragement of that work which can be well done outside of it.



No. 6, Old Palace Yard, Westminster, Wednesday, 15th June 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

THE MOST HON. THE MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S., a Member of the Commission, examined.

251. (*Chairman.*) I believe you have acted as examiner under the Science Department of the Committee of Privy Council on Education?—Yes, I have since the commencement of the system.

252. Will you be so good as to state the manner in which the examinations are conducted?—A letter is addressed to the examiner early in the year, requesting him to undertake the office and to prepare examination papers. When the time comes those papers are sent to the secretary of the Department of Science and Art, enclosed in a special envelope, and directed to the science inspector. The proof is returned to the examiner in a similar envelope, and is sent back again in the same way, so that great care is taken to prevent any improper inspection of the questions. Then as I understand, the papers are sent to all the schools which apply to be examined on the same day; that is to say, every school receives its papers on the same day, and the answers are written, under the inspection of the Committee, upon paper prepared with a proper heading, and furnished by the department. The numbered answers are returned to the examiner, who, without knowing anything about the schools from which they come, or the names of the candidates, affixes to them such marks as he thinks fit, and returns them to the department. There is a certain scale of marks which determines whether the candidate should be put in the first class or the second class, or should be rejected. There is a document which I asked Captain Donnelly to put in yesterday, giving the instructions of the department to the examiner, telling him what is the purpose of the examination, and giving him a sort of general direction as to the principles which should govern him in assigning marks, so as to get something like uniformity of action among the different examiners. Where the examination is a small one, the number of candidates not being very great, the examiner does the work himself. But where the examination is a very large one, as in the case of my own subject (for example, this year I had over 3,000 papers), according to the number of the papers, the examiner is empowered to nominate, for the sanction of the department, one or more assistant examiners. A meeting takes place between the examiner and his assistants, after the papers have come back to the department, and the examiner-in-chief takes some of the papers and points out what he considers should be the style of marking, what should constitute rejection, and what first-class, and so on, so as to secure something like uniformity. Then the assistant examiners take the papers away, each having his own batch allotted to him, and as fast as they are read they are sent back to the department. The examiner-in-chief then appoints another meeting with the assistant examiners, goes over a certain portion of the papers with them, and satisfies himself that they are doing their work fairly and tolerably uniformly. Generally three meetings of that kind are found to be sufficient, and the work is done in about three weeks from the time at which the papers are sent out. The schoolmaster is paid upon those who pass; he gets nothing for those who are rejected, and he is paid a

certain sum upon those who pass in the second class, a certain sum upon those who pass in the first class, and if any take honours, which they rarely do, because the examination is a separate and rather a stiff one, he gets a still larger sum.

253. Do you examine in more than one branch?—I examine in two branches, in physiology and zoology.

254. (*Dr. Miller.*) The results of one examination are not summed up with the results of the other examination; they are entirely independent, are they not?—Yes.

255. (*Chairman.*) By the method of employing assistant examiners you consider that a sufficient degree of uniformity is ensured to secure justice to the students?—Yes, I think so in my own case. I have been exceedingly fortunate, because the assistant examiners have been able and distinguished men. It is necessary that a very great amount of discrimination should be exercised; for although the questions are very simple, yet it needs men who know a great deal about the matter to form an accurate judgment upon them quickly.

256. The examination papers are entirely elementary, are they not?—There are three divisions. I ought to have stated before that the questions are set in three groups. There is an elementary stage, an advanced stage, and an honour division; the questions in each of those stages are separate, and the candidate must make choice of one of those three divisions. We endeavour to enforce the rule (it has been rather difficult in practice to carry it out, but gradually it is becoming enforced) that the candidate shall not go up for the advanced stage, unless upon some previous occasion he has passed through the elementary stage. That has been found necessary in order to prevent, as far as possible, mere cramming, and it is a very useful precaution.

257. Are the examinations held more than once a year?—The examinations are only held once a year, in May.

258. Those that go in for the advanced stage must have passed through the elementary examination in the previous year, must they not, or on some previous occasion?—We endeavour to secure that as much as possible. There are some practical difficulties which prevent the rule from being always enforced, but I have always tried for my own subjects to have it enforced as far as possible. I ought to state that by way of making the examination still more fair to the schoolmasters and to the candidates, a very elaborate statement is prepared of the precise subjects in which the candidates will be examined. There is one syllabus in animal physiology, and there is another in zoology, and the subjects in which the candidates in the elementary stage and the advanced stage will be examined, are laid down with considerable minuteness. The honours examination is left perfectly open.

259. (*Sir J. Kay-Shuttleworth.*) That, I apprehend, is given before the people begin to study?—It is published every year in the Science and Art Directory.

260. (*Chairman.*) Those directions are permanent?

T. H. Huxley,  
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15 June 1870.



*T. H. Harley,*  
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15 June 1870.

They do not vary from year to year, do they?—No, they do not.

261. Does the same rule apply to the honours division; must they have passed through the two preliminary examinations?—I think as far as possible. I am not quite sure what the rule of the department is about it, but I think that is the case; but the fact is that it is exceedingly rare for anybody to get honours.

262. Is the number that pass the elementary examination much in excess of those that go in for the more advanced examination?—I am not quite sure about the number; but I believe it is so. I have nothing to do with the returns; they are made up by the department, and I cannot say much about them. I have here a return of the results of the examination of science schools and classes in May 1869, which is the last return. In my own two subjects for that year, to begin with animal physiology, in honours 11 failed; there was nobody successful. In the advanced examination there is a statement here of the number for the year 1869, which gives 2,227 in animal physiology, and 303 in zoology; but that is of all classes put together.

263. Does the more advanced examination require a considerable further knowledge of the subject than the elementary examination?—Yes, considerably further.

264. (*Sir J. Kay-Shuttleworth.*) At page 50, Appendix B., 17th Report of your department, there is a table showing the per-centages of successes and failures in each stage in each subject, and also a table of the detail of successes and failures in each subject?—Yes, taking it together with the previous statement, that will give the whole. For example, in 1869 there were 2,227 papers sent in animal physiology. Out of that number, taking the elementary stage, there were 63 who passed in the first class, there were 291 in the second, there were 618 in the third, and there were 811 failures. I should say that last year, in 1869, there were three classes, but this year there were only two. In the advanced stage there were 42 who passed in the first class, 193 in the second, and 198 failures, making a total of 433, a small number as compared with the elementary. They get very much weeded in the elementary examination. In zoology in the same year there were 303 papers sent up, and of those in the advanced stage nobody passed in the first-class; there were 13 in the second, and 31 failures, making a total of 44 of the advanced stage. In the elementary stage there was one passed in the first class, 25 in the second, and there were 108 in the third, and 119 failures, making a total of 253.

265. (*Chairman.*) Have you formed any opinion as to the amount of good you are doing by those examinations? Can you say whether a considerable number of the candidates show such attainments in science as are likely to be of use to them in future life?—I have watched that very carefully during the 10 years that I have been connected with this system of examination, and I am fully of opinion that a great amount of good is being done by the system; and I think that the good will be immensely increased, with one proviso, that the examiners do their work with care and conscientiousness; that is at the bottom of the whole thing. When we began the system 10 years ago, it was of course necessary to be very easy with it, because people did not know how to teach physical science; and it was necessary to get the schoolmasters to understand that the thing was worth exertion; but as time has gone on I think that the examiners have seen the necessity of gradually raising the standard. As the schoolmasters became accustomed to the system, and as the method of teaching became thoroughly developed, so the standard has been gradually raised; and, so far as my own subject is concerned, I see a steady improvement from year to year. As in all other examinations there are a great many who pass with a very superficial knowledge; but I must confess that however superficial that knowledge may be, I think if it is honest, so far as it goes, it is all to the good. There is a wonderful difference in

the state of mind between a person who has never heard of a subject, and one who has forgotten what he has heard. Those two states of mind are almost infinitely different. Although I do not know but that if you were to put a very large proportion of those scholars through their paces a year after they had passed, they would cut a very bad figure indeed, yet I think that is the case in all examinations whatsoever, and does not militate against the conclusion that a very considerable amount of good, in opening people's minds and rendering them able to think, has been done by those examinations. At the same time I should say that there is a per-centage of candidates, and quite as large a per-centage as in any other examinations, who have really acquired a fairly respectable amount of thorough information upon the subject. I have been quite surprised, and so have my colleagues, the assistant examiners, at the character of some of the papers. I should think perhaps we might say 10 per cent. of the papers would come under the head of papers which would do credit to any teaching and to any examination of the same character; and so far as my experience goes, that is about as much as is to be hoped for from any sort of examination, and I have seen a great deal of examinations in my time. There is one great evil which we have had to contend with from the very commencement. The teachers see that it is possible to make a good deal of money out of it, and there are some of them who seem to have set their minds entirely upon trying to get money out of the system by simply cramming young children, and by putting them up, so to speak, to be shot at, upon the chance that they would get something out of it. The remedy for that is entirely in the hands of the examiners. If the examiners are lax, that system will increase, and the evils of it will increase until the whole system will do harm instead of good. I have not the slightest hesitation in saying that I believe that it is in the power of the examiners to stop it at once. It is perfectly easy for any person of experience to see whether a teacher is acting in this fashion, or whether he is not; and if he is, plucking 90 per cent., or more, of those he sends up, prevents his attempting, or at least discourages him a good deal from attempting, it again. Last year we had a considerable number of teachers in physiology up to London, for the purpose of giving them some instruction in practical methods of teaching, and with a view of improving the teaching in general. I took advantage of the opportunity to make an address to them upon that very subject, and to explain to them what I thought was my duty, and what was theirs; and what I proposed to do when I observed that anyone was teaching for the mere purpose of getting money without regard to the goodness of the teaching itself. I have reason to know that I gave some of my auditors great offence, but I thought it was proper that they should understand quite clearly what our relative duties were, and what I proposed to do, and this year I think there is considerable improvement in that respect.

266. Can you explain how there is such a much larger number in animal physiology than in zoology? Is it from the subject being more attractive, or do the candidates think that it would be more valuable to them in a pecuniary point of view?—No, there are two reasons for it. In the first place, I have had charge of these subjects from the beginning. I am quite convinced that as matters are at present, it is exceedingly difficult to teach zoology properly, and I set my face altogether against the sort of superficial teaching which was attempted. On the other hand, I have taken very great pains to organise a system for the teaching of human physiology, a subject with the elements of which I think everyone ought to be, and may be, acquainted.

267. After the examinations are concluded are you brought in any way into communication with the teachers; have you the means of forming an opinion as to which of the schools are really doing good work,



and which are not coming up to the mark?—If I like to inquire I can always find out. For example, on the present occasion there are one or two schools to which I mean to call attention in my report to the department, where it is quite obvious that things are not going on satisfactorily. In one school, for example, from which about 80 or 90 papers were sent up (I knew they came from the same school by the style of teaching, and by their being consecutive numbers), I found it my duty to reject between 70 and 80, or nearly the whole, and I shall make a special report upon that school.

268. As far as they are concerned there is no waste of public money, because most of their pupils are rejected, but there is a great deal of unnecessary work cast upon the examiners in looking over the papers?—To a certain extent there is a waste of public money. I mentioned in one of my reports in a former year, that I thought something should be done with those teachers who send up candidates in such condition, because the assistant examiners are paid by the number of papers which they have to examine, and consequently every paper which is sent up in an obviously unfit state, is so much money taken from the State without justification. It is not very much it is true, but still it is too much.

269. (*Mr. Samuelson.*) Can you give the Commission an analysis of the document for the guidance of the examiners that is issued by the department?—I am afraid that I could not trust my memory for that as it did not occur to me to bring it; but it will be very easily put in by-and-by. Having that in view, I mentioned it to Mr. Cole yesterday. It is strictly speaking a private document sent by the department to the examiners, but I presume that there could not be the slightest objection to publishing it. (See Appendix.)

270. Do you on the whole approve of the course laid down for examiners by the department?—Yes. It is the result in fact of a great deal of communication between the department and the examiners.

271. The assistant examiners, I think you said, are appointed by the examiner-in-chief?—They are recommended by him. The appointment rests with the Lord President.

272. But is the recommendation ordinarily followed?—Yes. The examiner-in-chief is held responsible for the whole examination, and all that the department does is to sanction the appointment of those persons upon his responsibility.

273. What, in your opinion, has been the effect of the change with respect to the mode of ascertaining the qualification of teachers, which took place about two years ago, on which Mr. Cole gave some evidence yesterday?—I think it has been unfortunate, and I should very much like to see that examination of teachers revived. In spite of all that may be said, I think that the former plan was a very great check upon the system of cramming. I should like to see all the teachers put through a special examination.

274. In spite of the great increase of the number of teachers which has taken place lately, you think there would be no difficulty in devising a system of examination which should not be very expensive to the State, and which should be effectual in securing a sufficient standard of qualification on the part of teachers?—I think so. I do not see why there should be any great expense connected with it, and I think that upon the whole you would save by the diminution in the number of bad papers sent up.

275. Would you require the teachers to come up to London for examination, or to certain centres to be defined beforehand?—I think it would be very difficult to manage it otherwise. I should like to make the examination practical. I should like to set a teacher to work (in physiology, for example), to show me how he would teach the circulation of the blood, or how he would demonstrate the structure of a sheep's heart, or something of that kind. It would be very awkward to get materials and appliances in every locality in which the teachers might be; therefore I

think it would be desirable, I will not say essential, that they should come to London.

276. To London or to some point where they would come into personal contact with the examiners?—Yes.

277. Even if there should be some increase of expense, you think that such a course would be so decidedly superior that it ought scarcely to weigh in the balance?—I confess that I do not think that the question of expense of that kind ought to weigh in the balance at all, because, if this system goes on, you will be expending 100,000*l.* a year before long, and it will be money very well spent, if the examinations are well managed. The per-centage upon such a sum as that of the expense of examining skilled masters would not be worth speaking about.

278. Have you paid any attention to the papers which have come up from the few science schools in which science is taught systematically during the day?—I have no knowledge of the schools. Unless anybody were to tell me what the numbers meant, I should not know from whence the paper came; and unless some special circumstance called my attention to a series of numbers, I should not inquire. It is rather better upon the whole that the examiner should not know anything about it. It gives a complete answer to people who are angry at not getting what they think they deserve.

279. Formerly you came into contact personally with the teachers, did you not, under the old system?—Only at the time that they were examined. I saw nothing of them at any other time.

280. At that time was there a large per-centage of those teachers whom you considered to be fully qualified for teaching elementary science?—They were not passed unless they were so qualified.

281. Are you aware what is the present standard for qualifying a person to become a teacher of elementary science?—I am not sure; but I think that a teacher has to pass in the advanced stage.

282. But not in honours?—No.

283. So that in point of fact a man may be a pupil one year and a teacher the next?—Yes, so far as I know anything about the working of that part of the system; practically there is no guarantee for the fitness of the teacher. Perhaps I had better read the 32nd article of the Directory upon that point:—"Payments are made on the results of instruction where it has been given by teachers who have qualified in either of the categories mentioned below. And no payments are made on account of instruction given in subjects in which the teacher is not so qualified. The qualification consists in having (a.) obtained a teacher's certificate in any of the before-mentioned sciences, according to the rules in force previous to January 1867," (those are the old rules,) "or (b.) obtained a first or second class in the advanced stage at the May class examinations since that date, or (c.) taken honours at the May examination." They say further: "In mathematics a first class in each stage will, from and after May 1870, qualify the holder to earn payments on the results of instruction in that stage, and a first class or honours in stages 3, 5, and 7, on the results of instruction in the preceding stages. Teachers already qualified to earn payments in 'elementary mathematics' are qualified in stages 1, 2, and 3, and teachers already qualified in 'higher mathematics' are qualified in all the stages of pure mathematics." The next article is this:—"The examination for qualification to earn payments on results of instruction will be dispensed with in the case of a candidate who has taken a degree at any university of the United Kingdom, or who has obtained the associateship of the Royal School of Mines, London, or the Royal College of Science, Ireland."

284. As I understand it, a man can only obtain payment on results in the subject in which he has taken a certificate?—That is so.

285. I believe that under the former system, when

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15 June 1870.



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15 June 1870.

there were special examinations, that was not the case. A man, for instance, having taken a certificate upon an examination in chemistry, was qualified to teach electricity or physiology, or any other subject within the programme of the department?—I cannot answer for certain, but I do not think that is the case.

286. At any rate you would not approve of it if it were so?—No, certainly not. I think they are obliged to take a separate examination.

287. (*Dr. Miller.*) It says, "Obtained a teacher's certificate in any of the before-mentioned sciences, according to the rules in force," that is the first qualification?—Yes: those are the rules now existing.

288. (*Mr. Samuelson.*) But the old rule was as I have stated, but you would not approve of it?—No, I do not see what the use of it would be; but the present rule limits it very definitely indeed.

289. With respect to the teacher's qualification, would you simply return to the old rules which were in force before 1867, or have you considered what would be the best rules to enforce with respect to teachers' examinations?—If I were to propose an ideal system (I do not know how far it may be practicable), but I should like to have all those teachers passed through a normal school in London, through a proper training school for teachers. That is what one would strive to have, and that the teachers should all take their qualification in the normal or training school. You will never get thorough scientific training in the country till that is the case.

290. Do you think it would be desirable to require that, even in the case of persons who are only to teach elementary science in night classes to adults?—I think it would be very desirable.

291. That in point of fact is a very strong argument in favour of the proposed school of which Mr. Cole spoke yesterday?—I do not quite know what may be Mr. Cole's views upon that subject, but it is, and always has been, a very distinct notion of my own. I do not see how you are to secure thorough value for the money which the State pays unless you have something of that kind.

292. Are you of opinion that such a school might also afford instruction to persons whose intention is to devote themselves to industrial pursuits, in fact that the proposed training school might at the same time be a school of mines, or a school of practical chemistry?—So far as the instruction in general science is good for all, I think that might be so, but undoubtedly the special instruction in mining or mineralogy might interfere with the instruction of teachers in the method of teaching. The two things are quite distinct. I do not mean to say that that difficulty could not be overcome, but the two lines of operation are two distinct lines.

293. But you do not see any difficulty in combining them in the same institution?—No, I do not see any difficulty in that.

294. In fact the cost of giving instruction to your teachers would be in some degree diminished by the admission of other students?—I think it might be, but still I confess that I should be very sorry to have the course of instruction requisite for teaching teachers how to teach, modified by the requirements of some other kind of teaching.

295. You would not sacrifice the one to the other?—No, I think the one is of far more importance than the other. I think that if you get a body of trained teachers all over the country, they will do your technical work for you very much better than you can do it in any other way.

296. Have you considered the question of how far the present staff of teachers in the School of Mines and in the School of Chemistry, and in the School of Naval Architecture could do the work of such a training school as has been shadowed forth?—There is no doubt that there is a foundation for a school of the kind. I know the organisation of the School of Mines best, and it is very defective in some respects. There is no mathematical teaching, for example, which

is a lamentable defect. Then there is an entire want in the School of Mines, as it now exists, of any means of teaching several of the subjects practically. For example, I am set there to teach natural history without a biological laboratory, and without the means of showing a single dissection. I am in the position of a chemist who should be set to teach chemistry without a laboratory.

297. And even for your preparations, that place is quite inadequate?—There is no provision whatever. I cannot teach in the proper sense of the word, so that I should think one could not say in the School of Mines more, at present, than that there is a nucleus of an efficient body.

298. As far as laboratories are concerned, is it the case or not, that the same laboratories would be available for the two classes of students; that is to say, the students who are to become teachers, and those who are now receiving instruction in the three institutions which I have mentioned?—That is a question of space, because students in a laboratory take up so much room, and of course while they are being instructed others cannot occupy the same space.

299. But the kind of laboratories is the same?—I presume so; but I should not like to go beyond my tether in that matter.

300. You say that there is no mathematical teaching whatever in the School of Mines, I believe that in teaching applied mechanics no reference whatever is made to mathematics, and there are no mathematical demonstrations possible?—I can give no opinion upon that subject.

301. Are you acquainted with the building which is now being erected at South Kensington?—No; that is to say, I have been in it, but I do not know it in detail.

302. (*Dr. Sharpey.*) With regard to examinations, have you ever considered that it would be practicable to check that tendency to send up unqualified candidates, by making some ratio in the payment between those that passed and those that were rejected; for example, supposing that 70 per cent. are rejected, and 30 per cent. pass, that the payment upon the passed should not be at the same rate as it would have been had the rejections been fewer. Until you get that better arrangement for training teachers which you are now referring to, might not some means of that sort be devised for checking the evil?—I think something of the kind might be done, and I have made representations to the department about it; I think that where the rejections are very bad, some notice should be taken of it. I think that the plan you suggest might not be a bad one.

303. It seems obvious from what you have stated, that they send them up with the mere hope or chance that they may draw prizes?—Yes. I should be glad to be understood that this is not the general case, but in every examination there will be a certain, and sometimes a considerable, number of candidates sent up upon that principle, or rather want of principle.

304. Probably if it is not checked it may go on increasing until you have the better means of training teachers?—Yes. It is a point which will always require the utmost vigilance in the examiner. If the examiner is an easy-going man he will always have his subject made a prey by the people who find it out.

305. (*Sir J. Kay-Shuttleworth.*) Yesterday you will have observed that in answer to a question put to Mr. Cole, it appeared that the great majority of the teachers in those local science schools were certificated teachers of primary schools?—Yes.

306. Also it was stated that those teachers are for the most part engaged in teaching in the morning and in the afternoon, during 2½ hours at each period, and that they have likewise to teach for an hour and a half their pupil teachers, and several of them have charge likewise of evening schools, and that it is after they have discharged those duties for the most part that they teach the science school; is that at all the



ideal system which you have formed of the mode of supplying elementary scientific instruction to the country?—No, I was not aware of the fact before; if the teachers work in the manner you describe, the fact may account for the very large per-centage of rejections.

307. Are you aware likewise that the Committee of Council on Education a few years ago rescinded a minute which previously restrained elementary teachers from instructing any evening schools whatever, after the instruction in the day school?—I have understood that to be the case.

308. You are probably aware also that the percentage of the money which can be earned in the elementary day schools, has from recent Acts of the Privy Council been somewhat reduced?—I have understood so.

309. Is it not therefore apparent that there is a great temptation to the teachers of the elementary schools to increase the amount of their annual income by teaching evening schools, and also science schools?—Clearly so.

310. You have already in answer to questions put to you by Mr. Samuelson, expressed your great preference for the system which preceded that recently adopted, of requiring a special examination in each of the subjects which the teachers selected for instruction in evening science schools?—Yes.

311. Taking into account all the circumstances which I have related, the great previous occupation during the day of the teacher, the exhaustion of his energies, and the temptation which he has to earn money by teaching, are you not of opinion that some portion of the instruction given during the 12 hours of the day, must suffer by such a constant occupation of his mind and energies?—Your statement conveys a correct impression of the daily work of the teacher. I should imagine that the whole of his instruction must suffer. I cannot conceive of a man giving thorough and good instruction under those circumstances.

312. You will observe that upon this matter being brought under Mr. Cole's attention yesterday, he admitted that the system must be regarded as transient and temporary?—Quite.

313. I have observed this morning that you are of opinion yourself that no course could be adopted which would give any clear and satisfactory elementary scientific instruction to the artisans of the kingdom, unless the teachers generally passed through a normal school in London?—I think that that is the ideal to be aimed at. I think that a great deal may be done in an imperfect sort of way without it, but I think one must look to that.

314. Are you not also of opinion that the teachers, in giving this elementary instruction in science, ought not to be engaged in day-school instruction?—My own feeling is that I should rather put it in another way; that is to say, that scientific teaching ought to be made a fundamental part of all primary teaching in the kingdom, and be made a part of the day's work. Unless I am greatly misinformed, the scientific instruction which is now current in the kingdom was the result, so to speak, of a battle between two official departments. I do not know whether I am rightly or wrongly informed, that it was in the teeth of the Educational Department that this scientific instruction was introduced; but, if such be the case, the fact accounts, I think, for the nocturnal, and somewhat surreptitious, position which science at present occupies. Sir James Shuttleworth can tell much better than anybody else whether such was the case or not. I think that is the way that we have dealt with science, not only in primary education, but in the larger educational bodies in the country; and my hope is to see science made an integral part of the elementary teaching everywhere in the country, and not to have it merely forced upon one department by another, as it seems to have been the case formerly.

315. You are aware that so far as positive legislation yet has extended, the school age has been defined

by the revised code as 11 years of age, and by the Factories' Act as 13 years of age, for half time. Have you much hope that any elementary scientific instruction which deserves the name could be given to a child before the age of 11?—Considering the difficult matters with which elementary education is now made to deal, such as the exceedingly difficult problems connected with dogmatic theology and the like, I think science might be taught quite as well. I think that the time which is devoted to the one might with equal success be devoted to the other.

316. Have you ascertained what degree of success attends instruction in dogmatic theology in elementary schools?—I can only presume from its being so strongly insisted upon, and made the subject of such a great battle at present, that it must have a great value.

317. I mean, do you know what degree of success it has attained?—I do not know.

318. Have you also observed in what standards the scholars ordinarily pass in the very best elementary schools, and under the largest and most efficient staff of educational machinery yet employed, up to the highest school age, in respect of ordinary elementary instruction, such as reading, writing, arithmetic, and geography?—I am not aware, I have not paid attention to that; but I may say in relation to this matter, that I have no doubt whatever that a certain amount of scientific teaching of a very valuable kind might be given to children of the ages now specified. I think that the nature of your scientific teaching must be very carefully determined, but I think that a great deal of what may be fairly called elementary science, with respect to the ordinary phenomena of nature, is information which might be made very complete in its way, although, of course, it would be very elementary; indeed, I am quite sure, from my own knowledge of children, that that may be given to children under 12 years of age, with extreme benefit.

319. That, of course, would be of a very different character from that which at present comes under the review of the examiners of the Science Department?—I do not think necessarily so. I think, for example, that children of that age may be taught elementary physical geography. I think it might be made a most important and most valuable subject of instruction, and not only of instruction, but of training, under that age. The elementary facts of physics (I am now using physics, of course, in its most elementary sense), I imagine may be taught with perfect ease.

320. You are probably well aware of the expedients which are adopted in some of the Swiss and Prussian schools with the object of teaching the simplest elements of the subjects to which you advert, such as in physical geography and geology, raised maps, and in the elements of mechanical science, small models of various descriptions, which are explained familiarly to the children, and so forth?—Yes.

321. Those are, I suppose, the forms of instruction to which, on the whole, you are now alluding?—Certainly, that is the main characteristic of any sound elementary scientific teaching. The great blunder that our people make, I think, is attempting to teach from books; our school-masters have largely been taught from books and nothing but books, and a great many of them understand nothing but book teaching, as far as I can see. The consequence is, that when they attempt to deal with scientific teaching, they make nothing of it. If you are setting to work to teach a child science you must teach it through its eyes, and its hands, and its senses.

322. You are aware of the suggestion of Dr. N. Arnott, the author of the *Elements of Physics*, for the instruction of the youngest children by means of objects of the kind which are called scientific toys?—I have heard of his propositions.

323. But, looking to any success in instruction in elementary science, in connexion with the manufactures of this country, I suppose that you would expect that the form of instruction which you would advise should be adopted in primary schools, should be

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15 June 1870.



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—  
15 June 1870.

developed in some secondary form in more advanced schools?—I think so.

324. And for that purpose a suggestion fell from Mr. Cole yesterday, that where practicable, secondary day schools, or secondary evening schools, should be established?—Certainly.

325. It was to these secondary day schools, or secondary evening schools, that my previous question had reference, when I asked whether you would not conceive it desirable that the teachers prepared for them should not have charge of elementary day schools?—Certainly not.

326. With regard to centres of examination to which Mr. Samuelson adverted, you are aware that for the examination for certificates under the Committee of the Privy Council for the teachers of elementary schools, training colleges throughout the country are employed?—Yes.

327. There would be, as you are well aware, in connexion with training colleges, and in future it may be so to a greater extent, a collection of models and apparatus and means of instruction in physical and experimental science,—might not those centres afford an opportunity of conducting the examination of teachers in various parts of the country?—I think they might, if you could get the examiners. The difficulty is to manage your examiners, if you have your examination centres scattered over the country; because the more you multiply your examiners the less is the chance of uniformity in the examination, and the more difficulty there is in dealing justly with the candidates; so that I think there is considerable importance in having a homogeneous body of examiners, men who will work together, and who in course of time may organise a continuous system to which the candidates may look.

328. Are you aware that the system adopted by the Committee of Privy Council consists of two forms, one the inspection of the fairness with which the examination is conducted at the local centre, together with any *visà voce* examination, or it might be in this case an examination in manipulation, which it may be necessary to conduct locally, and then the transmission of the examination papers to the centre to be distributed to the examiners: would not some such form as that greatly diminish the difficulties which you anticipate?—No. I think that that is putting the cart before the horse. As far as my own experience as an examiner goes, I think that the only thoroughly valuable form of *visà voce* examination is that which comes after the written examination, when you have read a man's paper and you want to know whether he really knows what he is talking about, or merely is writing very cleverly from memory. Such *visà voce* examination is invaluable, because it furnishes a commentary upon the written paper.

329. *Visà voce* examination, in the case of elementary teachers, is upon subjects different from that of the papers; for example, it is an examination in the power of instructing a class, or in some subject which could be better tested by *visà voce* examination, such as recitation or some other matters of that kind; and I was contemplating rather that the same method of individual examination might be applied to manipulation?—Just so. I misunderstood your question.

330. With respect to a training or normal school, without in the slightest degree anticipating whether it is desirable or not to depend for the establishment of a connexion between theoretic science and its practical application upon the action of the teachers in the country, or to make it form part of a normal school, would you propose that the following subjects should be mixed or separate, viz., first, pure theoretic science, then theoretic science in its application to some special object, such as mining or naval architecture, and then, thirdly, the method of instructing in theoretic science and its application, for example, to elementary or secondary instruction. By a greater occupation of the teacher's time, might those be grasped by any thoroughly competent man; as, for example, the application of mathematics to several

subjects, or of chemistry?—Putting it into a practical shape, and taking chemistry as an example, you would propose that the same person should teach theoretical chemistry; in addition to metallurgy and other applications of chemistry; what the Germans would call "pedagogics," or the method of teaching chemistry. I merely take that illustration and apply it in my own mind to the subjects which I am acquainted with, and I should say that it would not be a good method, for I think that anyone of those three things is quite enough to occupy a man's entire attention.

331. What you would prefer as I understand, is that the normal school should be entirely for teaching pure science, and the method of applying it to second-rate schools?—So far as it is a school for teachers, certainly. What I should like to see taught is science itself to begin with, and secondly, the method of teaching science.

332. May we not call it method in its application to secondary and elementary schools?—Yes, just so.

333. And you would be inclined to depend upon the exertions of a teacher instructed sufficiently in pure science and in method for the application of science?—Yes, I think that there is a great deal of misunderstanding as to the utility of the spread of technical education over the country. I do not think that much good is to be done by attempting to deal with the trades directly. In the scientific education of the masses of the people, the great object appears to me to be, to construct such a scheme as should enable you to sift out, and to get hold of the men who have really scientific ability. If you can pick out the men of intellect from the men who are only fit to carry water, and hew wood, and give them a fair scientific training, you may trust to the arts getting all that they want out of them.

334. Allow me to take an illustration from north-east Lancashire, the place where I live, surrounded by the following trades needing the application of pure science to the practical arts and industry of the country. We have mining, we have calico printing and dyeing, we have machine making to a very great extent, and we have the constant operation of the inventive faculty of the artisans, which is the real source of almost all the inventions by which the textile manufacture has been advanced. What I intended by my previous question, was to ask you whether your conception was that the establishment of a secondary school in such a region, in which the teachers who had been prepared in the normal school to teach certain departments of pure science, and who had an opportunity, either in the day or in the evening, of receiving into the schools the men who were practically engaged in those various forms of industry, was the most favourable opportunity for attempting the combination of scientific instruction with the practical arts of industry, rather than in the normal school?—That is to say, you would make your technical schools local.

335. Your idea is that the secondary school in which scientific instruction would be given would be local, and would be attended by artisans connected with the mining and printing and mechanical industry of the neighbourhood, and that those artisans would come to it for instruction in science connected with their several departments, and perhaps in other sciences, and my question was whether that combination was in your mind that which it is most expedient to establish?—In replying to Mr. Samuelson previously, I did not mean to raise any objection against establishing technical schools in London. All that I meant to say was that I thought that there might be danger in combining the technical school with the normal school; that is to say, that if you tried to get the same set of men to do both duties, the one set of duties would most likely interfere with the other; but I did not mean to express any opinion as to the utility of having technical schools in London or elsewhere.

336. I am simply desirous of eliciting your opinion as to whether the provision of the class of secondary



schools which I last described would diminish in your mind the importance of the creation of the other form of technical instruction by the Mining School or the School of Naval Architecture, or other technical schools in London?—No, I do not think that they would interfere with one another at all, they might co-operate to any extent.

337. (*Mr. Samuelson.*) You stated, did you not, that you thought some teaching of elementary science might, with great propriety and great benefit, be introduced into an elementary day school?—Yes, certainly.

338. Would you consider that the present system of examination by papers would be adapted to pupils of that class of school?—I should not consider it so good a system for the pupils of that class, for the quite young children that I am now referring to, as a *vivâ voce* examination.

339. You would consider it desirable that the examination should be conducted by the school inspectors?—Certainly.

340. You would not approve, I suppose, of the suggestion contained in Captain Donnelly's paper of 12th of November 1867, with reference to the teaching of science in elementary schools, that the Science and Art Department should make a return of the results to the Education Office, and that the function of the Education Department should simply be to pay upon those results?—If that proposition contemplate that education in science should be introduced into the ordinary day's work of the school, I think it would be exceedingly undesirable to have one person looking after three-fourths of the education, and somebody else looking after the other one-fourth. I think it important that whatever teaching in science there is, it should be put upon precisely the same footing as all other teaching.

341. That would involve qualifications on the part of the inspectors of schools, which, under our present system, they do not necessarily possess?—I do not see why you should not have scientific inspectors of schools as well as literary inspectors. There would be no difficulty whatever in sending round proper science inspectors to examine the schools *quâ* science.

342. But if the payments were to be made on results, the inspection should necessarily be local?—I think so, I think that for young children (and we are talking about teaching science to young persons under 12 years of age) the means of judging whether the work is properly done by *vivâ voce* examination is very much superior to that by papers.

343. In the papers which have been sent up to you and which have come under your notice as the result of the present system of examination, have you or have you not, detected a want of elementary instruction in what are familiarly called the three R's on the part of those who stand for examination?—Yes, it is a lamentable want, particularly in those cases to which I have just now referred, where the schoolmaster has evidently been sending up a lot of candidates simply crammed. I could almost pick out those papers by the handwriting and the spelling.

344. You have stated that the first requisite of a normal school of science should be that it should, in the first place, qualify the teachers in pure science, and secondly in the art of teaching?—Yes, certainly.

345. But having reference to the destination of the majority of those teachers, namely, that they should hereafter teach in secondary schools, would it not be desirable that they should have a general acquaintance with the application of those sciences to industry?—I am afraid that when you come to practical matters a mere general knowledge of the applications of science is likely to do as much harm as good. I can understand very great value attaching to a specific knowledge of the applications of science to an art, but a mere general knowledge it strikes me may be just as likely to mislead as not. It is very much like medicine. A person would do very unwisely who should endeavour to

doctor himself upon the strength of his knowing a little of physiology, or even knowing a good deal; he had much better leave it alone.

346. Putting it more specifically, assume that a teacher comes up to the normal school to be trained; assume him to come from a mining district, in which the management of mines is very much in arrears as compared with other districts, would you not consider it desirable that that teacher, knowing his destination to be such a district as I have described, should go through a course of instruction in a mining school, having special reference to mining?—I quite think so. If I could deal with that man as I pleased, I should put him first through the normal school that we are talking about, and afterwards I should send him to the School of Mines to go through a third year of special instruction in mining. But the instruction in the School of Mines is not mere general knowledge of the mining processes, it is very specific and particular knowledge. It is like the technical instruction of a medical school, to refer to my previous illustration.

347. Then so far as the classes could be held in the same building and in some manner connected, do you think that it would be rather an advantage than a disadvantage?—So long as the one class of work did not interfere with the other, and I do not see why it necessarily should in this particular case of which we are now talking; in fact it does not in the School of Mines at present.

348. (*Chairman.*) I suppose that the character of the examination papers that you draw up is hardly such as children at elementary schools under the age of 11 or 12 could be expected to be capable of answering?—I do not see any reason why a child of average intelligence, of between 11 and 12 years of age, might not be made to pass very well indeed in the elementary stage.

349. Such papers as you are in the habit of giving now for examination?—Yes, quite so. I think that a child between 11 and 12 might be very fairly and well taught sufficient physiology to be able to answer those questions.

350. As a matter of fact, I believe they are all considerably older than that, are they not?—The ages vary from 11 to 45. I was rather surprised yesterday at Mr. Cole's statement as to the average age. I should have thought that they had been on the whole rather younger, but no doubt he has better means of information than I have. I am bound to say that I was very much struck the other day, in looking over some of the results of the last examination, with the fact that, speaking roughly, the proportion of rejections is in the inverse ratio of the age; that is to say, of the older, upon the whole, the greater number pass, and of the younger the greater number are rejected. That, of course, is what you may expect from the present state of education.

351. If such a normal school as has been suggested were established, do you think that teachers could be trained sufficiently to be able to give instruction in any considerable number of those different branches in which the science examinations are held, there being, I think, no less than 23 branches?—I should say not any considerable number, but I do not see why they should not combine several. For example, I do not see why teachers should not give elementary instruction in both physics and chemistry, or in physiology and zoology, or in physiology and botany, and other allied subjects.

352. It would be only practicable, I presume, in very populous places, to have schools of such an extent that young men, wishing to obtain instruction in any of those branches, would be sure of being able to receive instruction?—Only in large places.

353. The greater part must be confined to a certain number of those branches?—I should think so. Of course a great alteration will take place if education is made compulsory over the country; and if the number of schools is very greatly increased there will be in almost any place somebody who may

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15 June 1870.



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be sufficiently instructed to teach in one or more of those subjects.

354. If science teaching were introduced into elementary schools, would it not be desirable that there should be a more intimate connexion between the Education Department, and the Science and Art Department, than that arising simply out of both being under one chief?—I must confess that I think the present state of affairs is an anomaly which could only exist in our own country. Separating the teaching of science from education, is like cutting education in half. It is a wonderful state of affairs, and the result is that practical antagonism, which I believe does not exist now, but which for a number of years, I am told, did exist, when one half of the department of the state which had charge of education was opposed to that which the other half was doing.

355. If scientific teaching were introduced into elementary schools, have you considered which of those branches would be the more important ones to introduce; it would be, I imagine, impossible to introduce all?—I think it would be extremely undesirable to attempt too much. My great fear of what educational reformers are now doing is that they are going in for too much. I should myself like to see the teaching in elementary science diminished rather than increased in range. I should like to restrict it in the first place, at any rate, to mathematics, to physical

geography, elementary physics and chemistry, and to botany and human physiology in elementary day schools. I think a great deal more good is to be done by restricting the teaching to a few subjects selected from very various regions of the whole ground of science.

356. I believe those are the branches in which practically the greatest number of persons offer themselves for examination at present?—I think they are. My reason for recommending them is obvious. Of course without mathematics it is impossible to go very far; in fact its importance as a matter of general training is immense; then, without a knowledge of elementary physics and chemistry, all further progress in science comes to an end; it is all loose and vague. Botany I recommend because it is the only branch of natural science which can be taught at first hand conveniently; you cannot teach zoology conveniently, but flowers and plants are always to be had and you can teach botany properly. Human physiology I recommend the teaching of for its practical importance, and it may be taught thoroughly and well.

357. At present I imagine to a certain degree mathematics are taught in the better class of elementary schools in the larger towns?—I imagine so.

358. But no other branch of science whatever is taught in elementary schools except physical geography?—I think not.

TRENHAM REEKS, Esq., examined.

T. Reeks, Esq.

359. (Chairman.) You are the Registrar, are you not, of the School of Mines?—I am.

360. Will you be so good as to furnish the Commission with a statement as to the organisation of that establishment?—It consists of a Director (Sir Roderick Murchison), and seven professors, with two assistants, and myself as registrar.

361. What are the direct objects for which this school was established?—To promote the mining industry of the country.

362. What means have been adopted for the promotion of mining industry?—There is an annual vote taken, lectures are delivered to students who enter the school, and the museum is open generally to the public. I should observe that the museum existed before the school, in fact the school was founded upon the museum of the Geological Survey, all of which is explained in the prospectus.

363. Are all the lectures directly connected with mining industry?—No, some are general, that is to say, those which are delivered in the first two years; and the third year's are special, the specialities being metallurgy, mining, and geology.

364. Those delivered in the first two years are I presume with a view to lay a foundation for those subsequent more special branches of lectures?—Precisely so.

365. Can you enumerate the different subjects of the lectures?—There are 40 lectures on inorganic chemistry, and 30 on organic, delivered by Dr. Frankland; there are 80 lectures on natural history, delivered by Professor Huxley; there are 50 on metallurgy, delivered by Dr. Percy; 60 on mining and 40 on mineralogy, both delivered by Mr. Smyth; 36 on geology, delivered by Professor Ramsay; 36 on applied mechanics, delivered by Professor Goodeve; 40 on Physics, delivered by Professor Guthrie; and there are 20 lessons in mechanical drawing.

366. Are all the students attending the School of Mines obliged to attend the whole of those lectures?—No, we divide them into two; those who enter for the three years, with the view of taking advantage of the whole of the courses, and those who enter for perhaps one, two, or more courses, as they please, and we call those occasional students.

367. Is the attendance at the lectures in any degree compulsory?—They are all registered, and unless they attend a certain number of lectures they cannot obtain their certificate.

368. If a student attended irregularly would he be

excluded from the benefits of the institution?—Not in any way, further than the loss of the lectures.

369. Are there any examinations connected with those lectures?—There is a final examination in every course, and there are other examinations which the professors themselves think fit to hold occasionally.

370. Then at the end of every course does an examination take place on the subjects to which that course refers?—Yes.

371. Are they classed according to merit or according to any other system?—According to merit, and the numbers that they obtain; they either get a certificate of the first class, the second class, or the third class, or they are not passed if they do not answer half of the whole number of questions.

372. What is the number of students at present in the School of Mines?—The total number of entries of all kinds for the session just closing, of 1869–70, was 103; of those, 17 were students who entered for the whole course, that is to say, for the whole curriculum, including the Government free students, and 86 were occasional students, some of them attending only one course, and some two courses, or perhaps the whole of the courses, but not wishing to obtain the certificate of the school.

373. Has the number been increasing latterly or the reverse?—For the committee of Mr. Samuelson I prepared a table, and I found that up to that period the average of the total entries was 84; but if I take the past 10 years I find that the average comes to 111, which of course shows a very considerable increase. In 1859–60 the total entries were 89, and in the following year they were 130.

374. Do the greater number of students attend the lectures of all the professors?—Not the greater number.

375. Can you give the Committee any information upon that point; do many attend two or more classes of lectures, or do a great many attend only one class?—The greater portion attend perhaps two or three courses. Upon the average, I should say that they attend three courses.

376. What number of professors are there altogether?—There are seven professors.

377. Do you know with what object in view the greater number of the students attend the School of Mines?—I think those who attend the chemical classes generally have some specific object to apply the knowledge to their own business, either as manufacturing chemists, or as dyers or brewers; and of



course, those who attend the special classes of mining and metallurgy have also a special object; but there are many, I think, who attend with the view of getting some employment by the interest of the establishment, in case they pass good examinations, or with a view to get on to the Geological Survey.

378. Are any considerable number of them ultimately engaged in mining industry in any form?—I think a very large proportion are, but we have no hold upon them after they leave, and, excepting by occasional correspondence, we cannot get any information as to what their occupation may be. I know that a large proportion are engaged in the metallurgical works at Sheffield and Swansea, and other large metallurgical industries. I may mention that the chief mining engineers of the city, Messrs. Taylors, have sent three or four of their sons to the School of Mines, with the view of their being educated specially for these branches of industry.

379. How are the payments that the students have to provide regulated?—If a student enters for the whole course of three years he has the option of paying a sum of 20*l.* in two successive years, or one sum of 30*l.* which frees him to all the lectures. Then there are laboratory fees, which are extra: the session is divided into three terms, and it is optional with a student to take one, two, or three terms, in order that he may pass his examination. Some can do it in two, and some in one, according as they are prepared.

380. Have you any limits as to age?—No.

381. What is the more common age at which students enter themselves?—I think from 18 to 22 or 24.

382. Do any considerable number enter themselves for the whole course?—The average is 14 per annum out of the total entries, of which 103 is the number for the present year, and 92 for the preceding one.

383. Are those 103 new entries this year?—Yes.

384. But the total number of students attending the school in one department or another I presume considerably exceeds that?—Yes, there are also the students who entered during the two previous years.

385. Do a good many usually fall off after the first year?—Very few, indeed.

386. The greater part of those who enter themselves continue during the whole course?—Yes, they enter with an object in view, and having paid their money they do not give up the lectures. I am now speaking of the regularly associated students, not of the whole 103.

387. (*Dr. Miller.*) Do you state that the 14 includes 14 new entries this year, and that in addition there are the entries of the two years previously?—No, the total number of entries for the past session is 103, and of those, 17 have entered with the view of pursuing the course extending over the three years, those we call "associated students," and the others "occasional," of whom there are 86.

388. But there are other students, are there not, of previous years, in attendance besides those?—Yes, there are other associated students of previous years.

389. (*Chairman.*) Those 86 occasional students do not enter themselves with the view of going through the three years' course of study?—No.

390. Then it is only the 17, or whatever the number may be annually, who enter with a view to go on through the whole course?—Yes, and of those 17 three are free students sent by the Government; the Government have the right of keeping nine free students at the school.

391. How are those free students selected?—They are selected at the May examinations of the Science and Art Department.

392. Do you know whether those are generally persons of superior ability and industry?—They must have very superior ability to obtain the studentship, because it is a competition of the whole country; and I may say that most of them get very lucrative appointments in the metallurgical industries after they leave the institution.

393. (*Mr. Samuelson.*) With the exception of

those students who are nominated by the Government, you have no guarantee whatever, have you, of any previous attainments on the part of those who enter?—Not any.

394. You have no matriculation?—No matriculation.

395. In your opinion does the term "School of Mines" correctly represent the functions of the school?—I think not, completely.

396. How should you describe it?—I may say that it was originally established as a school of mines, and in 1852 and 1853, without changing the constitution in any way, it was altered into "The Metropolitan School of Science." That I think very much impeded the progress of the school, because the object appeared to be changed, and the School of Mines abandoned, but in 1858 and 1859 the name was resumed under the title of "The Government School of Mines," and in 1862 and 1863 it was again called "The Royal School of Mines." I think those changes may have been prejudicial to the numbers entering.

397. Do you think it is generally understood that this school is something more than a mere school of mines?—No, I think not.

398. In point of fact, should you say that it is a technical school, a school corresponding in some respects with the Polytechnic schools of the continent?—It is very incomplete as that, because many sciences are untaught.

399. The Royal College of Chemistry is one of the departments, is it not?—It is the laboratory, in point of fact, of the school.

400. It was stated in evidence by Mr. Cole that several of the professors of the School of Mines have been obliged to refuse students, owing to the want of laboratory accommodation. Is that the case?—That applies to two only, that is with regard to the chemical and metallurgical laboratories.

401. Is it not the case that some of the other professors have complained of the want of laboratory accommodation for their demonstrations?—Certainly, as has been mentioned by Professor Huxley, the apparatus is very much confined in the space containing it; in fact the place is altogether full.

402. Has a wish been generally expressed that further accommodation should be provided?—Certainly.

403. Have you heard a suggestion that the school should be removed to South Kensington?—Yes.

404. Are you of opinion that such a removal would interfere prejudicially with the efficiency of the school?—I think that it is a choice of two evils. When the school was originally established the *raison d'être* was "The Museum and the Survey," and the advantage of having the museum in connexion with the school is no doubt very great; but the impossibility of enlarging and giving the professors their proper accommodation is so great, that one evil certainly weighs down the other.

405. The museum is useful, I presume, in illustration of certain lectures?—Yes, of certain lectures; and the contents of the museum are frequently used in illustration of the lectures.

406. And there would be some want of convenience on that account if certain classes were to be held in South Kensington?—There would be a certain amount of inconvenience, but I do not think it would be insuperable.

407. Have you anything to do with the Geological Survey?—Simply that as I act as secretary to Sir Roderick Murchison, who is the Director, I have a general knowledge of the details and the working of it.

408. Is it the case that the officers of the survey are also very much inconvenienced by want of room, and have made complaints on that subject?—It is so much so that the publication of their maps is most materially impeded. In fact we have now the same accommodation for 40 or 50 surveyors that we had originally for eight. There has been no extension, and the museum rooms which ought to be employed for exhibiting specimens

*T. Reeks, Esq.*

15 June 1870.



T. Reeks, Esq.  
15 June 1870.

are occupied as offices. That circumstance has frequently been represented to the Government, but the value of property in the neighbourhood is so great that no steps have been taken. Immediately inquiries are made, of course the price rises, and it has been found impossible hitherto adequately to accommodate the survey. On this point I know Professor Ramsay will speak very strongly, as he is mostly responsible for the publication of the maps. Although Parliament trebled, or nearly quadrupled the staff, with the view of getting the survey of the country completed, it has been delayed altogether, because the surveyors have no accommodation. They are obliged to work at home, and there is no superintendence of them; and altogether the work is very seriously impeded.

409. So that if the classes were to be transferred to South Kensington, you could easily find employment for the rooms which would be vacated?—Immediately, and even then the premises would not afford the room required.

410. Does the whole of the building in Jermyn Street belong to the Government?—Yes; it was built by the Government.

411. Have you not rented any houses contiguous to it?—We have one which is used for a metallurgical laboratory, for Professor Huxley's room, and for his assistants.

412. Is that on a long lease?—We bought the remainder of the lease I think, which belongs to the Government. I think it was purchased last year for 1,400*l.*, but for what period I do not know.

413. But the situation is one in which it would not be difficult, I suppose, to dispose of the lease again?—The lease of the house, of course, could be easily disposed of, but as to the museum it is built for a special purpose, and it would be very difficult to sell it. As to the house adjoining, I think the rent is only 114*l.* a year, but of course that would be taken to-morrow, as property is so valuable in the neighbourhood.

414. Is the College of Chemistry the property of the Government?—I believe so. I cannot speak positively about that, because the arrangements have always been made between the Department and the Office of Works, but I rather think it is the property of the Government, as we pay a ground rent to the Government for it. In the estimate, there is a sum taken for the rent of the College of Chemistry. They pay 470*l.* a year, but I believe it is merely out of one pocket into the other, or from one office to the other. I think, perhaps, the Office of Works originally rented it of the Office of Woods, or some arrangement of that sort.

415. With respect to the laboratory in Oxford Street, have complaints been made also that there is want of room there?—Not only have complaints been made, but students are actually refused; and in one instance a student had come all the way from India with a view to obtain a certificate, when there was no room for him. In fact, I think Dr. Frankland states that on the average six or eight are excluded almost every year.

416. Do you know anything of the condition of the laboratories there; are they up to the requirements of the present day?—Not in any way; they were built a great many years ago, and science has made so many strides that the laboratories are quite in arrears.

417. So that the want of an efficient laboratory is a hindrance to the efficiency of the teaching?—In every way, I believe. The metallurgical laboratory, I may say, is only a converted cellar; it was the rear of some premises in Jermyn Street, which were taken and covered over with a skylight of lead, and a few furnaces erected. It is a room about the size of this room or very little larger; there are 8 or 10 students working there each session. The session is divided into three terms, the spring, the summer, and the winter, and perhaps in the spring session eight, in the next session ten, and in the next session 17, and so on, making 35 a year; I do not mean separate entries.

418. (*Dr. Miller.*) That does not imply that there were 35 separate students?—No, not at all; our students may enter for one, or two, or three sessions.

419. (*Mr. Samuelson.*) It is the case, is it not, that students in the metallurgical laboratory come for short periods?—Yes, they come for some special subject, say to learn the art of assaying of gold, or silver, or copper, and then they enter for three months only.

420. Upon the whole, can you state whether the professors of the School of Mines would willingly acquiesce in the removal of the school to the premises at South Kensington, if they were well adapted to the purposes of the school?—I would rather not answer for the whole, some I think would, and some would not.

421. There is an objection on the part of some?—Yes. For instance, Mr. Smyth, who is very much occupied, and has his other occupations connected with Whitehall and the Duchy of Cornwall Office, I think, would consider it an inconvenience to have to go to lecture at South Kensington. Professor Ramsay, if his offices are at Jermyn Street, would consider it an inconvenience, also, but I do not know that they would object.

422. You have heard the subject discussed, but you have not heard any serious objection raised?—No, no serious objection.

423. (*Dr. Sharpey.*) You distinguish the associated students from the occasional students, and, as regards the associated students, I think you mentioned that there was no entrance examination?—No, nor for any student.

424. They spend two years in the school, I think you said?—Two or three.

425. The first two years, generally, in a preparatory stage?—Yes.

426. They then stay a year at any rate, to study applications?—Yes, the special subjects upon which they wish to become associates.

427. Do they pass any periodical successive examinations at the end of the several stages of their progress?—In order to obtain a certificate of associateship it is absolutely necessary to pass examinations on every subject, that is, the first two years' subjects, and the special subjects of the last year.

428. Before they are permitted to proceed from one stage of their progress to another, they must pass an examination, must they not?—Yes, in the third year they must pass in the first class.

429. Is there any examination during the first two years?—Always at the close of every course of lectures there is an examination, and they must pass that examination in order to obtain a certificate.

430. Has it been made a complaint that there is no previous teaching in mathematics conducted at the school in Jermyn Street; have there been any means taken to ascertain the proficiency of the candidates in mathematics, for instance, outside the school, before they are admitted to some of the subjects in the school—for example, to the study of physics or machinery?—No, the fact is that the deficiency has been found so great, especially in teaching those sciences which depend a great deal upon mechanical and mathematical illustrations, that it was represented to the Government, and the reply was that in view of this Commission and other things, they would defer it till further notice.

431. But was it not recommended to students, who were to proceed to the study of physics and mechanics, to follow their mathematical studies somewhere previously?—I believe it is still recommended in the prospectus that students intending to come should make mathematics a previous study.

432. Was any difficulty found in their obtaining that proficiency in that branch?—I do not know; but the difficulty is illustrated by the fact that they come unprepared, very few of them have any mathematical knowledge at all.

433. Supposing there had been an examination in mathematics before they were permitted to go on, would not that have ensured that they would have



gained their education somewhere else?—The only fear would be, that we should exclude many students if we were to hold that preliminary examination.

434. You mentioned that pupils who had passed that school and became associates, obtained appointments through the influence of the school; what is the nature of those appointments?—A list of public appointments is given in the directory. They are chiefly connected with the survey either of Great Britain or of the colonies.

435. Those are at the disposal of the Government, are they not?—Yes, those are at the disposal of the Government, or of Sir Roderick Murchison, on the Geological Survey of this country, and also mostly of the colonies on his recommendation.

436. Then it is only students who pass through the School of Mines that could obtain such appointments, I suppose?—No, it is not only those, the staff of the Indian survey is selected by Professor Oldham, and it is a staff of perhaps 16 or 18 men; it is only those whom he chooses to ask Sir Roderick to recommend, that go out there.

437. Are the appointments in the exclusive patronage of Sir Roderick Murchison?—The appointments on the survey are, but only those; he can recommend if applied to by the Colonial Minister, and generally does, if it is determined to have a survey of any of our colonies, and then they are appointed through his recommendation; but the students are given to understand that there is no certainty of any appointment.

438. But at any rate those appointments are for the most part confined to students?—For the most part.

439. They are probably found the most fitted?—Yes.

440. I think you mentioned that there were 17 regular associate students?—Yes, including the Government students.

441. The special instruction that they get is only in the third year, I believe?—Only in the third year.

442. The other lectures are all such as may be given elsewhere. I am not saying anything of the quality or extent of them?—Yes, I may say that all the four subjects are taught elsewhere, either at University College, or at King's College, in a greater or less degree. For instance, you have a professor of geology, Professor Morris, in University College, and a professor of chemistry, and I think of physics.

443. Have you ever calculated what was the expense to the State of the education of an associated student?—I have never made the calculation, but I have got the actual expense of the school as noted last year.

444. You see that that includes occasional students?—Yes, it includes all, but the calculation is very easily made.

445. I mean quite apart from the survey?—Yes, but I think it would hardly be fair to judge of the influence of the school by the associated students only. I may say that a very large item in the expenditure of the School of Mines, namely 645*l.* out of 4,000*l.*, is for the Government free students, not in any way connected with the school; it is merely subsistence money for those students.

446. And that is charged to the expense of the school?—Yes, that is charged to the School of Mines.

447. (*Professor Huxley.*) You spoke of the patronage of the school, but I presume under that head you included the applications which, as I understand, are often made to you personally to recommend somebody, by persons who are not connected with any Government department?—I did not include that; I included chiefly the direct patronage of the Government offices, but not, for instance, such as take place constantly. A manufacturer would come to me and say, could you recommend somebody; that occurs frequently. In fact only yesterday, a gentleman who had been sent by the Government, and had hitherto been employed in scientific teaching, has gone into an iron manufactory. I do not know whether the object

in sending those Government students is to train teachers, but if that be the object it is not carried out. The teaching does not pay, and a man goes into a manufactory where probably he makes with certainty some 500*l.* or 600*l.* a year, which he cannot do in teaching, and with uncertainty.

448. But it is a matter of fact, is it not, that the men who get exhibitions in the School of Mines now, are persons of exceptional ability?—I should say so, certainly, because you know from the examinations that they are chosen out of the whole country.

449. Could you mention the total cost of the school?—It is rather difficult to unravel the cost now, because the school and the museum are voted together, and the officers, for instance, the chemist and the metallurgist, were museum officers, but they are now both museum officers and school professors. That applies especially to the chemist and to the metallurgist; before the school existed those offices existed connected with the museum; but if we take the Director, who receives 300*l.* per annum, the seven lecturers 200*l.* per annum each, and one teacher in mechanical drawing 100*l.* per annum, there are besides the outfit and illustrations of the lectures 400*l.*, and the subsistence money and the few prizes that the Government grant 649*l.*, and the advertizing 250*l.*, which gives a total of something like 3,299*l.* as the annual expense connected with the school.

450. (*Dr. Miller.*) That includes nothing for rent?—No, but the building is the museum that existed before the school, at least a certain portion should be allotted to the school; and the cost of the College of Chemistry is 820*l.*, that is for rent, and furniture, and fuel, and light.

451. Are the salaries of the professors included in what you have stated?—Yes, there is 100*l.* a year to the chemist to the museum, 200*l.* to the lecturer, and the metallurgist the same.

452. (*Professor Huxley.*) Can you tell us how the present exceedingly inconvenient arrangement of having the chemical teaching at the School of Mines in Oxford Street, the school itself being in Jermyn Street, came about?—Originally the laboratory was in the museum, and it was found very inconvenient as to space, and the chemicals were detrimental to the specimens. At that time it happened that the College of Chemistry was I believe in a desponding state, and it asked relief from the Government, and by arrangement with Dr. Playfair, who was then the Secretary of the Department, the College was taken and the students of the school were removed to the college, and there are no longer existing chemical laboratories at the museum.

453. Do you think it would have occurred to the people interested in the School of Mines, supposing the College of Chemistry had not existed in Oxford Street, to have made that College the laboratory of the School of Mines?—No; precisely the same difficulties exist now, we could not accommodate the students.

454. But if you had to build a laboratory would you have built it in Oxford Street?—Certainly not.

455. Is it not the fact that there was considerable pressure put upon the Government, which gave rise to the transfer of the Oxford Street College of Chemistry to the School of Mines?—I believe that the college had not answered its purposes, and it was in such difficulties that unless the Government stepped in, the College of Chemistry must have become defunct.

456. I put the question, because it is obvious that a large sum in the way of rent, 800*l.*, has been charged to the account of the School of Mines, and it may be possibly that it is a highly unnecessary expense, that the work might have been done very much more cheaply if it had not been for the necessity which appears to have been felt by the Government of the day for taking over the College of Chemistry?—The rent probably was great, nay, more than that of the School of Mines, but you could not have built a laboratory for less than for that sum.

457. How was it that the School of Mines was not

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15 June 1870.



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13 June 1870.

originally provided with a laboratory of sufficient size?—The whole thing was an experiment; the museum was built, scarcely contemplating that the School of Mines would be established, and proper preparation was not made.

458. You were connected with the survey, were you not, at the time when it was in Craig's Court?—Yes.

459. And you are aware of all the circumstances of the transfer?—Yes, from the beginning.

460. At the time that the survey was in Craig's Court there was no intention of connecting the School of Mines with it, was there?—None at all.

461. And you had at that time sundry officers, such as a chemist and a naturalist and others, who were officers of the survey?—Quite so.

462. And the establishment of the School of Mines was a new idea?—A new idea, and the officers then existing had those extra duties to perform as teachers and lecturers at the School of Mines.

463. They were utilized, being there?—All, excepting one.

464. Was the museum in Jermyn Street built according to the ideas of the late Sir Henry De la Beche?—Yes.

465. Was he completely consulted about the construction of it?—I think completely.

466. Was it in his mind, do you think, at that time, that the museum was constituted for a school of mines or not?—I think not; I think his great notion was to apply the science of chemistry to agriculture; that was the topic of the day. Liebig had then published his great work, and Sir Robert Peel was very much interested both in chemistry and agriculture, and the notion at that time was, I think, more to advance the science of agriculture by geology and chemistry.

467. In the original plan of construction of the School of Mines there was provision made for a laboratory at the top of the house, was there not?—Yes, there was a laboratory constructed, at great cost.

468. That I believe is now Dr. Percy's upper laboratory?—Yes, and the upper lecture theatre.

469. Was that meant for giving instruction in scientific agriculture, or the application of science to agriculture?—Agricultural chemistry specially. I think Dr. Playfair paid more attention to agricultural chemistry, and it was erected on that account.

470. It was not contemplated at the time when the museum was built to have teaching, for example, in metallurgy?—No, there was no metallurgical laboratory provided.

471. Nor any dissecting room, nor any appliances for natural history teaching?—Not directly.

472. So that the whole School of Mines has been grafted, so to speak, and not a very clever graft, upon a very different plan?—It is a very difficult thing to do.

473. (*Sir J. Kay-Shuttleworth.*) With respect to the 17 students who in this year have taken the whole course, can you say what number of those have had any previous practical acquaintance with mining, or with metallurgical works, or with any other practical object for which they desire to educate themselves by theoretic teaching?—We have no means of ascertaining, except this: for instance, Mr. Siemens, the great engineer, has a nephew of his there, and he also has two or three of our students occupied in bringing into working his regenerating furnaces as applied to glass, and the manufacture of iron, and so on. Professor Huxley has his own nephew as a student there. Mr. John Taylor, the mining engineer, has also his son, but we have no means of ascertaining what their object is.

474. With respect to the gentlemen whom you have particularly mentioned, have you any knowledge whether they had spent any of their previous time in obtaining practical information in mechanics or engineering or mining?—I think they almost all come with an absolute want of any scientific training or knowledge whatever, without any practical know-

ledge, and this is a very great difficulty with the professors.

475. Are there not some who have spent their time, two, or three, or more years previously, for example, in connexion with some considerable collieries or other mines in the country?—There are a few, but the absence is noted, and I think it is occasioned by perhaps three causes. In the first place, I frequently find that parents are excessively loth to send their sons to be exposed to the temptations of London; in the next place, I think that the large manufacturers are of opinion that their sons would derive much more advantage by studying the working in their own works, than by coming to London; and in the third place, I think they all believe that they can purchase this scientific aid when they want it.

476. So that you do not think that the idea has at present obtained any considerable hold on the country, that a young man's education might commence, for example, in the collieries or other mines, or in the metallurgical works of his father, and that he might at a certain stage of practical information be sent to receive a scientific training in London?—No. I think it is stated in the prospectus that we should prefer the other mode of teaching, first the elements of the science, and then letting the students learn the applications of them afterwards.

477. I did not ask you what was the opinion of the department, but I asked you practically whether the particular course which I described had to any great extent been pursued on the part of the parents, of giving their sons preliminary practical instruction, and sending them up for theoretical instruction to the School of Mines?—I say that there are so few who really come from the manufacturing districts, that I hardly know what knowledge they have of practical applications.

478. The opinion of the school then, as I understand you, rather is, that you prefer to give the theoretic instruction first, and to send them for practical instruction to the particular branch of industry in which they were intended to be employed?—Yes. Perhaps I may be allowed to read a portion of the prospectus at page 4: "Of course nothing but experience in the mine and in the laboratory can conduct for the skill and tact requisite for the practical conduct of those operations, but on the other hand it is only by an acquaintance with scientific principles, that the beginner can profit by that experience and improve upon the processes of his predecessors."

479. Is that prospectus the work of the professors, or of the department?—This is prepared annually by the professors.

480. You mentioned that certain young men who had obtained great success in the examinations conducted by the Science and Art Department throughout the whole country, were elected to scholarships in the School of Mines, which provided subsistence for them, and a course of training there over three years, and that those young men so prepared and so trained, had obtained considerable appointments in some branches of industry in the country?—Yes.

481. Can you specify to the Commission the branches of industry?—Chiefly metallurgical, in the great iron and steel works.

482. In what parts of the country?—Sheffield specially, and in the copper works, and in the ironworks at Swansea; but I think that Dr. Percy, as far as he could, has kept a special register on that subject, and would furnish it to the Commission. I may say that there is one of our students who, I believe, leases property under Dr. Percy, and is a very successful coal miner, who states that half the coal of Staffordshire has been lost for want of a scientific knowledge of working.

483. (*Dr. Miller.*) I think I understood you to say that the entire expenses to a student who enters are, if the sum is paid in one sum, 30*l.*, so that for 10*l.* a year one of those exhibitioners, or rather one of the matriculated students, would gain the whole of the advantages,



with the exception of the laboratory, to be derived from the course?—Yes; the laboratory fees are not included in the 30*l.*, but the 30*l.* admits the students during three years to all lectures and examinations; if they pay it in two sums, it is 40*l.*

484. Are we to understand also that the fees are divided amongst the professors from each class?—Not wholly. A portion is reserved by the Government, and another portion the professors vote to me as registrar; one-eighth the Government retains, and my per-centage is one-tenth.

485. That is paid in addition to a fixed salary which the Government give to the professors?—Yes; just so.

486. The professors themselves have no expense whatever in connexion with the maintenance of the school?—None whatever.

487. They are found in assistants?—Yes.

488. And they are found in apparatus?—Yes.

489. And all specimens, of course, which are necessary?—Yes, the illustrations and diagrams there is a vote for annually.

490. Also, is it not the case that those gentlemen may apply to the Government for any sum which they think necessary for the proper maintenance of the school in a state of efficiency?—I think each year the vote has remained the same. There is a certain sum given by the Government to make the best of. I am not prepared to say if the Government were asked to increase it that they would do so. We have never asked for an increase, but we have made that annual sum of 400*l.* sufficient.

491. But in practice it is found that the grant which is given is adequate, in the opinion of those who conduct the establishment, to maintain it in its proper state of efficiency?—Just so.

492. So that, in fact, everything is found which is required, diagrams, assistants, and everything?—Yes, everything.

493. And the whole of the pupils have an opportunity of receiving such patronage as is placed at the disposal of the school?—Yes.

494. Are you aware whether it is the habit of the Government to place such patronage at the disposal of other institutions at all?—I am not aware at all.

495. With regard to almost all the scientific appointments, are they not practically offered to the School of Mines?—I shall only say, that, with regard to the Geological Survey, there are no chemical appointments, or at least I know of none.

496. Are there no appointments in metallurgical processes?—I know of none excepting as to the mints in India. The certificates of Dr. Percy are accepted for those appointments.

497. Would a recommendation from the School of Mines carry an appointment in India as assayer to one of the mints?—A special certificate of Dr. Percy, for instance, that the student had gone through a course of assaying, would be accepted; many of the Indian officers come with that view.

498. The metallurgical appointments that you spoke of are private appointments, are they not?—Entirely.

499. With regard to the College of Chemistry, are the laboratory expenses there also borne by the Government?—No.

500. Then there is a fixed sum paid, out of which whatever is thought fitting is expended in maintaining that laboratory?—The whole of the expenses of the laboratories, and the assistants in the laboratories, are paid by the professors, excepting the lighting and the fuel.

501. But are all the students in the laboratories considered pupils of the School of Mines?—Not at all.

502. Then is the College of Chemistry independent of the School of Mines in any sense?—It is only bound to educate our associated students in chemistry.

503. May they take any number of pupils they please, quite independent of the vote?—Yes, excepting that an annual return is made, and they are not put down as students of the School of Mines.

504. Still the Government pays the rent, and the

officers of that school have no expense connected with the maintenance of the building, or with the rent, or in fact with any of the conveniences, gas, and water, and so on?—No. The three items that are voted are rent 430*l.*, furniture 150*l.*, and fuel and light 200*l.* With regard to the assistants, I do not know how many there may be, they are paid for by the professor himself.

505. Are the appointments of the College of Chemistry made by the Government independently; has it any separate existence, or is it now entirely merged in the School of Mines?—Entirely. All appointments are made by the Department of Science and Art.

506. I think you stated that there was a metallurgist attached to the museum, what are the duties of the metallurgist attached to the museum independently of teaching?—To make any assays, or any investigations upon the specimens which may be either there, or may be sent to the museum, and to catalogue the contents of the museum; the metallurgical contents are under his care.

507. But is it supposed that that gentleman has an opportunity of making investigations for the public for payment which he receives from them, or does he make them entirely as an officer of the institution for the public?—He makes them for the public if he pleases.

508. That is to say, he is entitled to take remuneration from the public for private work?—Yes, for private work he may.

509. Is the same thing true with regard to the chemist to the museum?—I believe it is quite true.

510. Has the chemist in fact any duties connected with the museum beyond those of actually giving instruction?—He is liable to be called upon to make analyses of any water, or any soils, or any ores, collected by the Geological Survey.

511. And that is actually done, is it?—It is done occasionally.

512. He receives 200*l.* a year for the purpose of being enabled to make them at any moment when it is desired that he should do so?—No, he receives 200*l.* for his lecture duties, and 100*l.* as chemist to the museum.

513. I think you stated that there is an indisposition on the part of parents to send up their sons to London for the purposes of instruction. You are perhaps aware that there are institutions, King's College, for instance, where a good many manufacturers do send their sons to London for theoretical instruction, and they go down afterwards to carry out those instructions in practice?—Yes, but I think both the King's College Institution and University College have some means of either boarding the students, or the professors will receive the pupils, or in some way be responsible for their morals. I think there used to be a boarding hall at University College.

514. (*Dr. Sharpey.*) That is alongside the college, but quite independent of it, it is called University Hall, and was established independently of the college?—But still I think the college would guarantee its respectability; it is a kind of home where the students can go. I merely say that they would send them up to the institution if there were any place where the students could be looked after.

515. (*Dr. Miller.*) In King's College there is a residence for a certain number, is there not?—Yes, there is.

516. (*Marquis of Lansdowne.*) I see in your evidence before Mr. Samuelson's committee, you speak of some students who are sent up from the Inland Revenue Department, upon what terms are those students sent up?—They only attend the lectures, and the fees for the lectures upon both subjects, that is to say, organic and inorganic chemistry, would in the ordinary course amount to 6*l.* each.

517. Are they already in the employ of the Inland Revenue?—Yes, and they subsequently are employed in the laboratory department for detecting frauds and adulterations, and so on.

*T. Reeks, Esq.*

15 June 1870.



T. Recks, Esq.

15 June 1870.

518. Are you aware that either the customs or the excise benefit considerably by the facilities which the college affords for giving those sort of attainments which are requisite in laboratories, and that in both departments they employ a great deal of laboratory work?—I think the practical part is all taught by the departments respectively, but they only have the advantage of attending the lectures, and Dr. Frankland, I believe, acts as their examiner, before they are officially appointed.

519. There would be no reason, I suppose, why, just as these departments appear to benefit exceptionally by the existence of the college, the other Government departments should not do so likewise, where scientific attainments are necessary?—No reason at all.

520. I understood you to say that there were certain appointments of which Sir Roderick Murchison had the patronage and nominations to the Indian mints, obtained by means of certificates; should you say that patronage of that kind was a considerable inducement to those students to attend the college, and that upon that patronage depends whatever popularity the college possesses?—I think a great many students enter with the view of getting employed by Sir Roderick Murchison on the Geological Survey. The assaying appointments in the mints are in no way connected with it, the authorities merely accept the certificate. I believe the appointments are made in India.

521. I suppose it is rather with reference to those kind of appointments, than with reference to the success, for instance, in trade which such education would be likely to ensure, that the students attend the lectures?—Yes.

522. (Chairman.) Can you state what is the average number of appointments at the disposal or at the recommendation of Sir Roderick Murchison annually?—On a recent occasion when the survey was increased so very largely, there were a great many appointments made, and if a student had passed well in the School of Mines, he had a certainty of preference, but there may not be another vacancy for a year or two or three years, and if a candidate came from outside, and were as good or a better man, he would have that appointment; it is open to public competition.

523. Is it open to public competition under the Civil Service Commissioners?—The Civil Service Examiners have lately been relieved from the examinations for survey appointments, they being considered only temporary.

524. Then the appointments to the Geological Survey are not confined to students at the School of Mines?—Not necessarily.

525. But practically, are the greater part of them appointed from amongst the School of Mines' students?—Not the greater part.

526. (Sir John Lubbock.) Is it done by competition before the Civil Service Commissioners?—No, it used to be done first of all by competition under Professor Ramsay in the special subject of geology, and then it was necessary, in order to complete the appointment, that the individual should obtain a Civil Service certificate.

527. Is that still necessary?—That is not necessary now.

528. Then the Civil Service Commissioners have nothing to do with it?—They have nothing to do with it; the recent appointments are considered temporary only.

529. (Chairman.) They are considered to be temporary, but are they really so?—It is to be hoped that the survey will come to an end some day.

530. They are only temporary in this sense, that the survey itself will come to an end?—Yes; but in case of sickness they are not considered as entitled to a pension without a Civil Service examination.

531. What are the fees paid by occasional students?—That all depends upon the number of lectures given. If the course consists of 30 lectures and under 40 the fee is 3*l.*; if it is above 40, for any number above 40 it is 4*l.* Then all officers in the army and navy are

entitled to come for half fees. All civil servants on foreign service at home on furlough are also entitled to come for half fees, and all gold medallists and all certificated schoolmasters may come at very considerably reduced fees.

532. Are the students supplied from various classes of the community?—Yes.

533. Not any, I presume, from quite the artizan class?—No, not from quite the artizan class.

534. They are not able to afford the cost or the time probably?—No, we have special courses of lectures for artizans delivered in the evening at which they can attend.

535. What are the rules with respect to those lectures?—Each applicant has to bring his name, address, and occupation written on a piece of paper, and for this he receives, on payment of 6*d.*, a ticket for a course of six lectures upon any one subject taught in the school.

536. Are they numerous attended?—We have more applicants than we can grant tickets for, and in some cases we have known several hundreds turned away. The theatre admits 600, and frequently those tickets are all applied for and taken within an hour.

537. Is there a separate ticket for each lecture, or for the set of lectures?—For the course of six lectures.

538. I think you said that the College of Chemistry is often obliged to reject students for want of space, does that happen in the case of any other professor's lectures?—I should explain that we have been obliged not to exclude them from the lectures but from the laboratories, and there are only two, the chemical and the metallurgical laboratories.

539. If the metallurgical laboratory had better accommodation provided for it, and the public wished to make use of it they would be able to do so?—Yes, Dr. Percy has put that upon record in the department.

540. I think you say that a great number of students are found very defective in mathematics?—Very many indeed.

541. Has not that had any tendency hitherto to remedy itself, that is to say, have not students from their experience of their deficiency in mathematics attempted to gain mathematical knowledge by other means?—There are different students every year, and the last class has no knowledge of the preceding class of students, in that respect.

541*a.* One would think that if students were incapable of deriving the advantages that they otherwise would from the course of instruction at the School of Mines, if that fact became generally known, the students of subsequent years would take means for getting the instruction elsewhere?—The professors themselves thought it so important that they applied to the Government to appoint a professor of mathematics, which would be the easiest remedy.

542. (Professor Huxley.) I presume in answering Dr. Miller just now, you did not mean to suggest that Jermyn Street was worse off than any other school where there is no guarantee for the care of the students?—Not at all.

543. You are, I suppose, aware that nine-tenths of the young men who come up to pursue their studies in the medical schools simply live by themselves in lodgings?—I am aware of that, and our School of Mines will compare most favourably with the *École des Mines* in France, or with the *Bergakademie* at Freiberg in point of numbers; but I speak of it as a deterring cause to parents sending their sons to the School of Mines.

544. You do not mean to say that there is anything special in the School of Mines in that respect?—No; it is the same with regard to any school.

545. Are you acquainted with the number of students in the Bergakademie?—The total number of students for 100 years from the foundation of the Bergakademie (1766–1865) is 2,465. At the School of Mines the number in 19 years has amounted to 1,641.

546. And also in the *École des Mines* of Paris?—No. I do not know whether the numbers have been published. On this point I speak from hearsay only.



547. (*Mr. Samuelson.*) You stated that the prospectus was prepared by the professors; do they form a council of studies, or is there any organised action on the part of the professors to control and to make the studies harmonize?—It is always done by the council of professors, presided over by Sir Roderick Murchison himself. It arranges the school, and the details of working, and the amount of fees; and every award of prizes and every consideration is adjusted by the council.

548. How should you describe the government of the college?—I hardly know how to answer the question. It is probably governed by the director and the professors, subject of course to the Lord President's approval.

549. You were asked whether a saving might not be effected by other Government departments, besides the geological survey, having their work done in the laboratories of the School of Mines. Have you any accommodation for that; is there room in the laboratories for such work?—There is no laboratory accommodation. I think, for instance, that the Government of India, who now require their students to pass many of the subjects that we teach in the school, might obtain their information there, and it probably might be so altered as to contain all that the Government of India require.

550. That is to say, if your laboratories were larger?—Yes, and probably the arrangements of instruction might be made to accommodate so large a class of students.

551. Before the school was established, was there any difficulty in procuring competent persons for the conduct of the geological survey?—There was no difficulty, but the survey was limited to 8 or 10 persons; Professor Ramsay and Professor Jukes, and all were distinguished men, merely employed as surveyors, and Prof. John Phillips, who was also on the staff.

552. In the present state of circumstances is it the case or not, that the operations of the geological survey are greatly facilitated by having access to persons who have been educated in the School of Mines?—Yes, I think so.

553. With reference to metallurgy was there before the establishment of the School of Mines any school in London or elsewhere in the United Kingdom in which metallurgy was systematically taught?—I do not know, but I think at that period metallurgy was considered a portion of chemistry, as one of the applied portions, and most chemical laboratories I should think would have had furnaces and other apparatus to teach assaying; in a large chemical laboratory they would have had that attached to it, I think.

554. That is to say, that metallurgy was made a department of chemistry instead of a special science?—Yes.

555. But in the School of Mines it is a special department?—Quite so.

556. And you are not aware of there being any special department of metallurgy in any other college?—Not in any other school in England.

557. (*Chairman.*) Are the Commission to understand that the College of Chemistry is now strictly a

Government institution, and not partaking in any sense of a private character?—It has no private support.

558. Do you know anything about the object of the artisans who attend the evening courses of lectures; there is no examination, I presume?—There is no examination.

559. Have you any means of knowing whether they come with a general view of acquiring knowledge, or with the intention of turning it to any special purpose?—I should say most decidedly that they come for the purpose of acquiring knowledge, and not generally for any special purpose. For instance, Professor Huxley gave a course of lectures on "Man's place in Nature;" you would hardly imagine that working men could apply such a subject.

560. (*Professor Huxley.*) Is it not a matter of fact, known to those persons who are acquainted with the School of Mines, that working men as a general rule take far greater interest in abstract questions, questions of general science, than they do in matters having a direct application to their own pursuits?—Yes, I should certainly say so. For instance, the lectures in metallurgy, which you would fancy would be most easily applied, are not the best attended. And I may say again that those lectures to working men of course are exclusively for working men. We have had many applications from persons who are not artisans, and with the view of accommodating them other courses of lectures have been established at a slightly advanced fee, namely 5s. for ten lectures, but I cannot say that they have been nearly so successful as the working men's lectures; the average attendance may be from 175 to 200, even with the lectures of Professor Tyndall. For instance, at the working men's there were not only 600, but many were turned away.

561. (*Mr. Samuelson.*) In fact you get nearly as much from the 6d. as from the 5s.?—The 6d. is merely a guarantee of the man's intention to attend, and moreover the working man has a special feeling that he does not like to be admitted for nothing.

562. (*Professor Huxley.*) That all goes to the Government, does it not?—The 15l. hardly pays more than the expense of advertising.

563. (*Mr. Samuelson.*) By the 5s. do you make more than you do by the 6d.?—Yes; but even 5s. would hardly pay for advertisements.

564. (*Chairman.*) Are there several of those courses of lectures for working men?—The whole of the subjects taught at the institution are lectured upon, four subjects in one year, and then three and then four again, and then three, so that every professor has in the course of two years to deliver one course.

565. No subject is lectured upon every year?—No, the subject varies; for instance, in the case of geology, it is not simple geology, it may be the geology of England, or geology generally. Some of Professor Huxley's may be on the use of fossils, or some point in natural history, but the lectures are rarely repeated as such.

566. Can any associate of the School of Mines obtain a certificate without any knowledge of mathematics?—Yes.

The witness withdrew.

Adjourned to Friday next, at 11 o'clock.

*T. Recks, Esq.*

15 June 1870.



No. 6, Old Palace Yard, Westminster, Friday, 17th June 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

THE MOST HON. THE MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
TREAS. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

ANDREW CROMBIE RAMSAY, Esq., LL.D., F.R.S., examined.

A. C. Ramsay,  
Esq., LL.D.,  
F.R.S.

17 June 1870.

567. (*Chairman.*) I believe you have acted as examiner in the Science Department of the Committee of the Privy Council on Education?—I have.

568. In what branches of science have you been examiner?—In geology only.

569. What opinion have you formed as to the value of those examinations?—My opinion is, that they are tending to spread a knowledge of geology through the country, but in not a very satisfactory way, for one or two reasons, which I will state, if the Commission wish. The first is, that the teachers, in some cases, do not seem fully qualified to give sound instruction—I do not say in all, but in some cases. The second reason is that a great number of the pupils, judging by their handwriting and style, are too young to undergo such examinations. Also, that with a number, judging by their handwriting (for I know nothing whatever of the pupils themselves, or their names or residences), their education is too imperfect for them to undergo such examinations. Many spell very incorrectly and write exceedingly bad grammar, and they do not properly understand the meaning of words. Also it appears to me that some of the teachers, of all whom I know nothing personally, are apt to get up their knowledge by a special process of self cramming, and that from that imperfect kind of knowledge they cram a number of the younger pupils whom I guess to be mere children, and who answer by rote, and I infer this from the fact that sometimes a number of those children answer the same questions in the very same words.

570. Do those remarks as to the deficiency in the qualifications of teachers apply to a very large proportion of institutions and schools?—No, I should say not; but I have not attempted to estimate the proportion.

571. Are there a considerable number of young persons examined annually in geology?—They have been gradually increasing every year since the examinations were first instituted. I forget what number we started with, but this year the number had increased to 1,067. I think if I recollect rightly that must have been an increase of at least 400 or thereabouts over the previous year.

572. Do you remember what proportion of them were successful?—Rather more than one half were plucked, and most of those who passed, passed in the elementary stage; the advanced were comparatively few. If I had known that I was to be asked those questions I could have given you the precise numbers, but they may be obtained from the Science and Art Reports.

573. You have, I believe, an Honours class?—Yes. I have an Honours class. Last year was the first year that there was an Honours class, or classes, and with me they were all plucked last year. This year 20 came forward, and three passed; two first class and one second class. The two first-class in Honours were very good, and the second class, I may say, was good also.

574. (*Sir J. Kay-Shuttleworth.*) Have you any knowledge whether they derived their instruction simply from those science teachers or from any other source?—I do not know, but they are at liberty to

come forward, I believe, without any instruction from science teachers.

575. (*Mr. Samuelson.*) They must have attended a certain number of lectures, I believe?—I cannot answer that. I think it is perfectly free to everybody.

576. (*Chairman.*) Should you say that any improvement is visible from year to year on looking back for three or four years?—Last year I considered that there was a considerable improvement. This year I think not, and it may perhaps be accounted for by the much larger number that have been brought forward, so many of them apparently being children.

577. And would you say that a good number of the teachers are not competent to teach?—I would not say that they are not at all competent to teach, but I think they are not competent to teach geology in a very effective manner.

578. Has it occurred to you that any further restriction should be adopted with reference to those teachers; that persons should not be allowed to teach without some means of ascertaining previously whether they are not better qualified than they are at present?—I have not considered the question.

579. Have you thought of any means of weeding out a certain number of the schools that are not doing any efficient work?—No, I have not thought specially of the subject; but the way to weed them out is to pluck strictly when the pupils are bad, and then the masters will get less or no Government remuneration.

580. And that you do freely?—Yes, that I do in a conscientious manner.

581. I understand that there are a very large number of the candidates who from the character of the answers that they give prove that they are quite unacquainted with the subject?—Many of them quite unacquainted with the subject. They do not even know the meaning of the answers that they are giving.

582. That entails, does it not, a good deal of trouble upon the examiners, without being the slightest advantage to any one?—Yes, without being of advantage to any one, excepting the examiners, who are paid according to the number, and Government saves money by the plucking of ignorant pupils, preventing teachers getting money on false pretences.

583. Have you thought of any plan of weeding out those who are wholly incompetent?—I have sent a report to South Kensington stating the numbers of those whose teaching seems very bad, or who have brought up a great number of incompetent persons to be examined, and I have stated them by their numbers; that is all I know about them.

584. Have you the means of ascertaining where the candidates come from?—No, I have no means of ascertaining where the candidates come from, but the papers are tied up in special bundles, arranged in suites of numbers. One bundle may contain 50 papers, others only one or two. Then this year, for the first time, being very much disgusted with what had taken place, I have specialised those whose teaching, or rather whose pupils, were very bad.

585. (*Mr. Samuelson.*) How many of those bundles have you?—I did not count them, but I could easily find out.



586. Will you be kind enough to let the Commission know how many bundles which we should conclude would be distinct classes were presented to you, and state at the same time what proportion of those you thought it necessary to report unfavourably upon?—I think if you will apply to South Kensington they will give you a copy of the report.

587. Still we should like to know what proportion it was to the whole?—I do not think I have got the means now, but many of the bundles, as they are called, only contain one paper.

588. But still that would represent a class?—I presume it does, but I know nothing about that.

589. Are you acquainted with the change which was made in reference to the examination of teachers some two or three years ago so that, whereas formerly teachers were subject to a special examination, they are now examined with their pupils, and if they pass in the first grade below honours, they become qualified to earn payment on results?—I am not aware of that.

590. Do you consider it necessary that teachers should have a special training apart from that of those whom they are intended to teach?—My opinion is that no one can teach geology properly without having had a very special training, and made it a special branch of study, and indeed I believe it is impossible to teach it in a first-class style unless the teacher has had a great quantity of practical experience, quite irrespective of what can be got from books. I think that through the country generally, with a few exceptions, geological teaching is in a very unsatisfactory state for great part of the United Kingdom, not only with regard to the science masters, but in very high quarters indeed, such as some of the universities. I speak of the United Kingdom, not of England specially, and it is better in England than in some other parts of the country.

591. Are you aware that a number of teachers came up to South Kensington during last summer for the purpose of being instructed in the method of teaching?—Yes, I heard of it.

592. Did you come into contact with any of those men?—No, I was not asked to give a course.

593. How long have you been an examiner?—Ever since the system was started, as far as I remember.

594. Do you examine all the papers yourself when they are referred to you?—I did up to this year, but when you have over 1,000 you are allowed an assistant. Last year it was considerably under 1,000, and I did it all myself.

595. You reviewed some of them yourself?—I reviewed an unusually large proportion, being the first year; I think about 397 or 398, or something of that kind.

596. Did you at all check the work of your assistant?—Yes, of course.

597. In what way?—In that way, also in guiding him all through. He was in my company most part of the time.

598. So that your assistant would refer to you on any point on which he might be doubtful in his own mind?—Yes, he did so.

599. So much so that you would consider yourself responsible for him?—I consider myself entirely responsible for him.

600. Had you any experience before the change of system: there was a time when each instructor was examined and his qualifications were tested; did you have experience at that time of the qualifications of those who were sent up?—I forget the details, it is so long ago.

601. (*Dr. Sharpey.*) I presume from your account of the results of the examinations that you infer that the instruction given is chiefly from books?—Yes.

602. Do you see any evidence of the pupils really having a knowledge from any other way, from specimens or any practical knowledge?—Very rarely. In very few instances pupils seem to have gone on geological excursions, and a few candidates seem to go into the field; at any rate as far as collecting fossils is concerned.

603. You characterise the large number that are rejected, as in the first place quite insufficiently prepared in their ordinary general education?—Yes.

604. And you presume them to be very young?—A great number of them, I presume to be so, by their handwriting.

605. At what age do you think that a boy might advantageously be instructed in the elementary facts of geology?—I think they might begin at an exceedingly early age, in the same way that all children who have any education at all, for example, know some of the elementary points of astronomy, so certain questions involving geological knowledge might be instilled into them.

606. Would you do that by means of the aid of specimens and plans, and the like, and not merely books?—Not merely books, but by the aid of specimens and by the generally better educated state of the whole of the public. It might be part of a household education, quite irrespective of the teaching in schools, if scientific education in the country were placed on a proper footing.

607. Do you presume that the teachers are induced to send up candidates that are quite insufficiently prepared, in the hope that they may pass, and payment be obtained for teaching?—I have suspected that.

608. We are informed by Professor Huxley that in the case of animal physiology and zoology a very large proportion were in the same condition that you now speak of with regard to geology, has there ever occurred to you any way of checking that?—None, except what I have stated by rejecting them.

609. How would it answer to make the payments partly dependent upon deductions to be made for rejections; would not that check the tendency to send them up on the chance of success, because at present you see there is no chance of a loss?—I should like to be better acquainted with the whole of the minor workings of it before I could answer such a question.

610. (*Professor Huxley.*) I think the nature of the examination and the manner in which it is conducted are such that until it is over the examiner has no means of knowing anything of the school, or the teacher, or the name of the person examined; is that not so?—He has no means of knowing it as a rule. In my examination I sometimes can infer it from the examples that they give of pieces of geology in this part of England or that part of England, as the case may be, or Ireland, or Scotland.

611. I forget whether since you have been examiner the teachers have been brought up to London for examination, or not?—I have been an examiner all the time, and I do not remember anything of the kind.

612. Do you think that there would be any use in bringing up any proportion of the teachers to London and giving them instruction in the art of teaching geology in the same way as they received instruction last year in the art of teaching physiology and chemistry?—It certainly would do them no harm, and I think it might do a proportion of them some good.

613. Do not you think that the failure in many cases proceeds from the teachers not being aware that geology is a subject which cannot be taught from books?—Yes, it cannot be taught perfectly from books alone.

614. (*Sir J. Kay-Shuttleworth.*) It has transpired in the course of the examination that a majority of those who are employed in conducting the science classes in the country are occupied during the morning and afternoon, and even some portions of the evening in elementary instruction; in fact, that they are certificated masters of day and evening schools. Taking into account that the pupils of the science classes belong for the most part to the operative classes of the country, and that many of them are very young and imperfectly prepared, should you consider that instruction in such a subject as geology, by such teachers, is likely to lead to any permanently satisfactory result?—Yes, I think it will lead to somewhat satisfactory results. If the classes are large there must be a considerable number of the pupils whose

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17 June 1870.



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minds get very considerably opened by that kind of teaching, even though it may be imperfect.

615. I gather from what you have previously said that you scarcely believe that specimens are much employed in the instruction of those pupils whose papers come before you for examination?—I think not; for when I ask a question that involves a knowledge of the shape of fossils or the nature of a rock, the answers are generally very imperfect.

616. Still less do I conceive that the pupils can have had any opportunity for instruction in what may be called field geology?—As far as I know or can infer almost none of them have had any instruction of that kind.

617. Even regarding the very humblest forms of what you have just now described as household instruction in the elements of geological knowledge, something like a conception of the geological structure of the neighbourhood would I apprehend form a portion of such household knowledge?—Yes, it might very well do so; also some of the large and leading facts of geology that are akin to the large and leading facts of astronomy, such as the great and unknown age of the world and the great and varying succession of life in time, so as to disabuse their minds from the crude and erroneous conceptions which nine-tenths of the British and all other publics have upon such subjects.

618. But supposing, for example, that there was a tolerably good geological section occasioned by the action of a river in the neighbourhood, and that that section was open as a point of demonstration to a teacher, you would at least think that the teacher should be competent to give his class the benefits of the natural illustration which was so afforded?—Certainly.

619. And further, that if a school were situated in some remarkable mining district, for example, in a district in which there were remarkable seams of coal, the structure of the immediately neighbouring coalfields might be made a very proper source of instruction by means of diagrams?—Certainly. One point that I would insist upon in all good geological teaching is the capacity of the master to illustrate what he teaches with chalk and a black board, and also the pupils ought to be taught to do the same thing for themselves. The very fact that they use their hands and eyes in such a work will tend to give them a conception of the meaning of what they are attempting to delineate.

620. Supposing that there were in the neighbourhood of any school of instruction remarkable evidences of the erosive action of water upon a valley, such as river terraces and various alluvial deposits in different parts of the valley, would you think the teacher competent, in the first place, if he were unable to give illustration to his instruction from those natural objects, or pardonable if he omitted it?—I should think he was incompetent if he could not do it and very blind if he did not do it.

621. Looking to the nature of the answers which have been given to the questions which have been brought under your notice as examiner, do you think that such a degree of competency has been attained or that such instruction has been generally given?—I think not, as a general rule. I should say that a very considerable number of the teachers have that competency, but not as a general rule. I would give an example. I have been in the habit at intervals of giving a question, and it is for the advanced pupils. "Draw a section across any part of the country," (meaning Great Britain and Ireland,) "with which you are best acquainted, and explain it." In very few cases have I got a satisfactory answer to that question, and I have repeated again and again in my reports to the Department of Science and Art that none of the pupils in connexion with it seem to have any notion of drawing, neither do they understand the relations of the strata in their own neighbourhood, proving that they are not instructed in that branch by the teacher,

or that they have not understood him if he did instruct them.

622. So that when you say that you conceive that considerable advantages are derived, even from the very incompetent teachers, and the very imperfect modes of instruction adopted at present in those science classes with respect to geology, I apprehend that you mean that even a very vague and general explanation of geological facts must transpire which may be important as an element of popular instruction?—Yes, it is of some value.

623. In fact, if you desired that anything like such an amount of instruction in geology as would be likely to have a beneficial influence upon the mining industry of the country should be given by means of schools, you would not seek to give it by means of those science classes, but rather by secondary schools with thoroughly trained teachers?—There would be more hope of its being well taught in that way. At the same time I am not prepared to say that some of the science classes do not, to a considerable extent, fulfil that object.

624. In such cases have you any means of knowing whether or not they are connected with mechanics' or other institutions, having other classes of science and other means of training the students to prepare them for receiving the instruction of those more advanced teachers?—I have no means of knowing.

625. It may be therefore that in fact when you say that there are evidences of some practical instruction having been given, it may have been derived from something approaching the character of a secondary school?—I cannot say from the papers.

626. (*Professor Stokes.*) You said that you thought that no satisfactory instruction could be given in geology by a teacher who was not himself acquainted with the subject in a practical manner; that is, I may say, acquainted with field geology; have you formed any opinion as to the means by which teachers throughout the country could acquire that knowledge?—The only way in which they could acquire it so far as I know, and I have often recommended persons to practise in that manner, is to take the best published geological maps and sections of the district, and go out with them in their hands and work backwards and forwards over the country until they begin to understand the meaning of the lines and colours on the maps and sections, and the reasons that induced the person who made the maps to depict the geology as it stands. I have recommended a great number of persons, amateurs, to do that, and it has been successful in a great number of cases. There are a great number of people who think they understand a geological subject very well from reading about it in books and consulting the diagrams there; but some of those persons have come out with me into the fields, and there they were utterly helpless, and I might almost say, totally ignorant. It would be the same, I presume, as a person understanding theoretically a good deal about chemistry from reading, and being turned suddenly into a laboratory and required to analyse a rock or a mineral.

627. Then I understand that you think that a teacher, by the aid merely of books and a geological map of the immediate neighbourhood of the place where he lived, could acquire for himself that practical knowledge which you deem essential?—If he had a good natural talent for the subject; not otherwise.

628. Could anything be done in that direction by his coming up for a time to a training institution situated, say, in London?—Not much could be done in the way of teaching people how to observe in the field in that manner. You could not teach botany without flowers, and you cannot teach geology in that sense without examining the rocks in place; but you can prepare a man's mind to understand and appreciate it when he fairly sets to work. That is all that can be done in geology proper by lecturing in colleges or schools.

629. Do you think that this sort of self instruction in practical geology would require the expenditure of



a considerable amount of time on the part of the teacher; that it would require leisure for certain parts of the year from other pursuits?—If it were a bore to him it would, but if he liked it it would not. There are a great number of persons in the country scattered about, some of them men in a very humble condition who like the subject so much that they have acquired a great deal of knowledge. Sir James Kay Shuttleworth has known several of them in his district. And so much so that when a geological survey of trained and professional geologists comes into their neighbourhood they are able at all events to save them a very considerable amount of time by giving information which would cost the surveyors a considerable amount of time to find out for themselves.

630. (*Dr. Miller.*) Do you consider that a theoretical knowledge, apart from this practical knowledge of geology, is desirable or not?—I think it is desirable.

631. Then supposing that this practical knowledge were not attained, you would still prefer that knowledge of a theoretical kind should be imparted to boys in a school?—I would certainly.

632. (*Marquis of Lansdowne.*) I think in one of your reports last year you drew the attention of the department to one set of papers which showed evidence of this cramming system of which you have spoken. Was that owing to the exceptional character of the case, or would it be the usual practice in your reports to notice any evidences of such a system?—Certainly now it will always be my practice.

633. The department, I suppose has an opportunity of discovering by the numbers from what part of the country the pupils come and so forth, but I think you stated that you only know the pupils and the teacher through the papers?—The department know all about them, but they purposely keep us in ignorance, and I am very glad to be kept in ignorance. I cannot help knowing it sometimes, but it is no matter whether I know it or not.

634. You would prefer that the examiners should continue to be entirely in ignorance?—Yes, certainly.

635. (*Chairman.*) Have any of the teachers in any instances applied to you for advice for improving themselves as teachers in geology?—I am not certain. Now and then I get a letter from a teacher and I always answer it. Once the teachers held a meeting at Liverpool to condemn the severity of the examiners. I do not know whether Professor Huxley was condemned, but I was. Then I wrote to one of the teachers, Dr. Birkenhead, who had been one of my old pupils, in a friendly way asking him if he would be so kind as to point out what questions or what parts of the questions were of such a kind that he considered them too severe, and he was unable to give any single instance, but that the general effect was of that kind.

636. You think that a theoretical knowledge of geology is worth obtaining, quite independently of a practical knowledge?—I think that a theoretical knowledge is worth obtaining quite independently of a practical knowledge.

637. Do you think that a teacher who has himself only a theoretical knowledge is capable of imparting that theoretical knowledge without having also a certain amount of practical knowledge?—He is capable of imparting a great deal of knowledge to children which probably they would otherwise never know, but he is incapable of teaching geology in the highest style.

638. You are also the professor of geology in the School of Mines, are you not?—I am.

639. Are those students who are attached to the School of Mines with a view to becoming associates, all obliged to attend your course of lectures?—They are.

640. But besides that, other students have an opportunity, have they not, of attending them if they please?—Anyone may come who pleases.

641. The number of those who attend your lectures

with a view to becoming associates is not large, I believe?—No, it is not large.

642. Does the course extend over more than one year?—Only one year.

643. Does it come in the first year?—No, in the second year.

644. At the close of every course, or possibly oftener, are you in the habit of examining the pupils?—Yes, I am.

645. Do you practically have an examination annually, or more frequently than that?—Formerly I used to examine them three times, but now for the last two years I have confined myself to a final examination. The reason is that they are so worried with examinations that it distracts their minds too much from other studies to be obliged to go in oftener for examination.

646. Are those who voluntarily attend your course of lectures also examined?—They may come if they like. I ask every one to come that chooses.

647. Do the greater part voluntarily undergo the examination?—The younger ones do. When I say the younger ones, I mean men under 25, perhaps.

648. Do a considerable number attend your lectures in whose cases you have no opportunity of testing whether they have acquired valuable information or not?—A varying number of middle-aged or even old people come, and one gentleman has attended my course almost every year for many years.

649. And he has never yet gone through an examination?—No, but I should think that he is as old as I am.

650. Are those who attend the lectures, with a view to becoming associates, persons of considerable ability as geologists, and have they an aptitude for learning that science?—Many of them have shown great aptitude and passed very high examinations, and distinguished themselves as geologists since, and are well known to scientific men.

651. Are you satisfied with the present regulations of the School of Mines in your department?—I am perfectly satisfied with them.

652. You do not recommend any alteration?—Not in my department.

653. A considerable number of those who have attended your course of lectures have distinguished themselves as geologists, or have obtained appointments as such subsequently, have they not?—Yes, a considerable number.

654. And have many of those who voluntarily attend your lectures distinguished themselves in anyway?—Yes, some of them have distinguished themselves—more, probably, than I can remember; but some of them have distinguished themselves, and travel about the world and write very good papers, on what I would call advanced subjects in geology.

655. Do many persons of leisure attend your lectures merely with a view to acquire a knowledge of the science for their own gratification?—Some do that.

656. But have the greater part of them some practical end in view?—I should think one half of those who are not associates have a practical end in view, not perhaps with the intention of practising as professional geologists, but gentlemen who are home from India, Canadians, gentlemen from the United States (one of whom is Professor Brush, the distinguished mineralogist, another Colonel Tate, and a third a son of Admiral Maury's), officers of the Indian army, and men of that kind; they come and attend that they may have their eyes open to what they will see when they go back to their duties or to their own countries. Students have also been sent to the School of Mines by the Turkish Government, and others have attended from Italy, South America, and other foreign countries.

657. Have persons largely interested in mining been in the habit of sending up students in order that they may be employed subsequently in those districts?—A considerable number have attended with that view. I am not aware that many have been sent by the mining districts specially for that object.

658. I mean mineral owners or lessees of mineral

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17 June 1870.



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*Esq. F.R.S.*  
17 June 1870.

works?—The sons of such gentlemen have attended with that object, indeed a good number.

660. (Mr. Samuelson.) Have many of your pupils become teachers?—Some; I do not know how many.

661. Is it any large proportion?—I should think not very large, but I have no means of finding out. One (Mr. Blanford) is now Professor of Geology in Calcutta.

662. Are there not a number of young men who are sent up by the Government after a very difficult examination at South Kensington?—Yes, there are some.

663. Do you find when they come to attend your classes that their abilities correspond with what you would expect from that examination?—Yes.

664. You have no entrance examination with respect to any of your other students whether they be occasional students of associated students?—No.

665. Do you think that that is a desirable state of things to continue?—Yes, I would make it as free as possible. I would give every facility to people to attend.

666. You would not exclude any person owing to his want of preliminary preparation?—No.

667. You stated that the sons of persons engaged in industrial or mining pursuits come up to your classes; do they come more frequently as associated students or as occasional students?—As associated students, I think.

668. Are you aware that great inconvenience has been felt by some of the professors of the School of Mines owing to the want of room in that institution?—Not as regards the School of Mines. I have heard of no inconvenience for want of room there. I have never conversed with anybody upon the subject. I have found no inconvenience myself.

669. You have also the direction of the Geological Survey, have you not?—Yes.

670. Have you ample accommodation for the business of that survey in Jermyn Street?—No.

671. Will you have the kindness to state what the defects are under which you are labouring?—From want of office room, and the want of space for the exhibition of geological specimens as far as the museum is concerned.

672. Have you made any representations upon the subject to the Government?—Frequently.

673. Have you received any replies?—Verbally.

674. What has been the general tenor of them?—Want of money, I think.

675. Have you made any definite proposals on the subject?—I am not quite sure that definite proposals have been made in writing, but I think so. To give us a sufficient quantity of room, it has been proposed more than once to the Government to buy that low building that lies between the side of the museum and the lane that leads along by the back of St. James's Church, between Piccadilly and Jermyn Street. There is a tailor's shop there of one story, and if that were built over with properly constructed buildings, all our difficulties would at once disappear. The office rooms would then be quite sufficient for the Geological Survey, and the offices that are now occupied by Mr. Hunt and myself might with great advantage be employed as that portion of the museum that would be used for the exhibition of rock specimens. The space which is now used for the exhibition of rock specimens has for so long been utterly crammed that we cannot exhibit one more. The office rooms are also utterly inadequate. There are three rooms in use between Mr. Hunt and myself and our officers. One of those rooms is Mr. Hunt's private room and the other is my private room. A room lies between them, which would not be nearly big enough for my men alone, and yet his men and my men are crowded into it together. All sorts of gentlemen, and others, are calling daily for information on this matter or that matter connected with mines, or connected with the Geological Survey, that requires the pulling out and exhibiting of maps, and a great quantity of conversation, which impedes and stops the

work in such a serious way that in many cases I may say that half of a whole day is wasted by the very bad economy of space that has been practised towards us. By work of the office I mean the preparing of maps and sections for publication, writing memoirs, and other matters connected with the Geological Survey; and, in Mr. Hunt's department, with which I have nothing to do, drawing plans, and so on. If all the three rooms were thrown into one, and given to the Geological Survey, it would then be not half big enough for us. The Geological Survey in Ireland is about one third of the size, as regards men, of the Geological Survey of England and Wales, and yet they have three or four times as much room as I have in London. The Geological Survey in Scotland is scarcely one quarter the size, and the Government has given them fully three times as much room as Mr. Hunt's place and mine put together, and it is not too much for them. I have struggled under this inconvenience for a number of years, and done my best, and represented it to my superior officer, Sir Roderick Murchison, and, before his time, to Sir Henry De la Beche, and it has been represented at South Kensington, but up to this date, without any effect. They are exceedingly good-humoured about it, and it ends with good humour.

676. Are there not several other rooms in that building which are now used for the purposes of the School of Mines?—There are several rooms used for the purposes of the School of Mines; for example, there is the large lecture hall down-stairs, then upstairs there is the small lecture hall, and there is a small laboratory besides adjoining it, occupied by Dr. Percy, and there are the cellars where the metallurgical laboratory is.

677. Are there not also rooms occupied by some of the other professors, the professors of palæontology, and so on?—Yes, they are in an adjoining house, and very bad rooms they are.

678. Supposing the School of Mines were to be removed from Jermyn Street, would those rooms, of which you have just spoken, be of any material service to the Geological Survey if they could be appropriated to that purpose?—They might be of use to the Geological Survey if you could keep the rooms that are now used by the Geological Survey as well; but then the museum would suffer, and the museum is suffering from plethora now, that is to say, if you were to remove Dr. Percy and the small lecture hall, you might transfer the Geological Survey and Mr. Hunt to the other end; but then we should be just as much cramped for room as we are now.

679. (Professor Huxley.) It is a matter of fact, is it not, that the rooms which the survey at present occupies, insufficient as they are, are really rooms that ought to be applied to the purposes of the museum?—Yes, they were intended for it originally. The part that we are now in has been temporarily employed by the Geological Survey, and it was constructed formerly with a view of taking down the wooden partition wall, and afterwards throwing it into the museum, and from the beginning it was always intended as the place to exhibit the rock specimens when the Government would be so kind as to give us sufficient room in an adjoining building for the geological survey.

680. (Mr. Samuelson.) You consider that if the School of Mines were removed, even then there would not be sufficient room in Jermyn Street for the necessary extension of the museum and for the purposes of the survey?—Not unless they built.

681. But they would have to build less if the School of Mines were removed?—They would have to build less, but the rooms are very ill adapted for the purposes of the office as they now stand.

682. Was any valuation made of the land and buildings which would have to be taken upon the plan which you have suggested?—I cannot answer that, I do not know; I do not think it was ever fairly proposed. I believe the person that it belongs to, at least it is said that he would ask so much for



the good-will of the business, and all that kind of thing, that it helped to impede anything that might be done in that way; so I am told, but I know nothing of it specially.

682. Do you consider that it would be a great advantage to teachers in geology as teachers, if they were acquainted with the general range of experimental science?—Certainly it would be a great advantage to geologists to have a very high knowledge of all sciences, but I have never known a geologist who possessed it. Geology embraces so many considerations that are connected with every other science that the more a man knows the better; but you never find a geologist who is a perfect chemist, a perfect botanist, a perfect astronomer, and so on; it is impossible to find such a man.

683. Would you consider it or not to be of value to a teacher of geology that he should have received a certain amount of instruction in the other branches of experimental science?—Certainly.

684. Then you would consider it an advantage that there should be some establishment in which he could receive instruction in the range of those sciences?—Yes, or establishments.

685. You distinguish between an establishment and establishments; have you any particular object in making that distinction?—Yes; I think it would be a great hardship if he was not allowed to get his information where he could, at the various universities or anywhere else, that are scattered about the country.

686. And do you consider that there are at this moment scattered about the country various institutions where he can receive that knowledge?—There are scattered about the country various institutions where he can receive that knowledge. I do not say in every branch perfectly. We have no such institution that I know of in the world. For example, in Scotland there is no place that I know of at present where I am at all certain that geology is thoroughly taught. The reason of that is, not that some of the professors are not good geologists, but that there is no special chair of Geology at any of the universities in Scotland. There are chairs of Natural History, and that is supposed to embrace geology, mineralogy, zoology, palæontology, and I do not know what else besides. The result of that is that when a new professor is elected he often chooses and gives a preference to the particular branch of natural knowledge with which he is best acquainted, and that is taught at the expense of the others, so to speak. In my youth there was a professor of Natural History at Glasgow, whose chief claim to be a naturalist was that he understood mineralogy, but so few people attended him for years before his death that he never gave a lecture at all. Professor Jamieson, who was so distinguished, was also well known as a mineralogist, and also, as Dr. Sharpey reminded me, as a meteorologist, or at all events he treated of that subject in his lectures; his chief claim to be a geologist was that he was a mineralogist. I am not aware how far he touched upon other subjects, but it was quite well known that he was not competent to teach all Natural History in general, and as for geology his latter style of teaching was behind the age. At Glasgow the chair is also a chair of Natural History. The present professor, Dr. Young, is an excellent geologist, I know that personally, because he was for a long time on the Geological Survey under me; he is competent to give very good lectures on geology, and he is bound to give courses of various kinds. He teaches zoology and he teaches geology, and I dare say some other subjects, but it is quite clear that it is impossible for one man to do justice to the whole of those subjects. As it at present stands, I consider that it is very deplorable that in Scotland some of those chairs are not broken up and two or three professors appointed where one is now. In Aberdeen there is a chair of Natural History, and the professor there is Professor Nicol, who is a geologist and a mineralogist,

and who also, I believe, teaches Natural History generally; but it is quite understood in Edinburgh, and everywhere else, that it is impossible for any man to teach all the branches of science embraced under Natural History, and the general result of it is, that one branch is tolerably fully taught, and the others are often either slightly touched on, or not taught at all.

687. That is so far as Scotland is concerned; can you give us any relation of the state of things at the English Universities?—At the English Universities geology for a great number of years at Oxford and Cambridge has been very well taught. There were Buckland and Strickland, and now there is Phillips at Oxford. At Cambridge there has been Professor Sedgwick before I can remember anything on the subject, and Professor Stokes can give you any information about him, I have no doubt. He was a great teacher. In Durham I know nothing about it. I do not think that there is a professor of geology at Durham. At University College geology has been taught well, as far as I remember. My predecessor was Mr. Webster. Then I taught it myself, and I was succeeded by Mr. Chapman, and now there is Professor Morris, who everybody knows is a distinguished geologist. The defect of that chair is that no profit accrues from it. When I was there for four or five years I forget what the amount of money that I made from it was, but I think it was never more than from 25*l.* to 30*l.* a year; nevertheless I taught it with as much zeal as if it had been a great deal more, but I never intended to do so all my life. At King's College there have been excellent professors of geology. Sir Charles Lyell was there, Professor Phillips was once there, and Professor Ansted was once there. I believe that it is compulsory on students of engineering to attend a course of geology there, and therefore the remuneration from that source necessarily makes it of considerably more value (not that it is very high) than the professorship at University College. In general I have no hesitation in saying that such branches of science as taught at universities, will never give an adequate amount of remuneration to the professors from fees only. There is not a sufficient demand for the special kind of knowledge. It only indirectly, as a general rule, leads to professional employment, or assists people much in professional employment, and if it is worth teaching at all, it is worth while to have it taught in the best manner; and to have it taught in the best manner, the men must be paid beyond what they can get from the fees of pupils.

688. Then in some way or other it would be necessary that an endowment of chairs in those special subjects should be provided?—It would be necessary in order to get good men as a rule.

689. And if that endowment were provided by the Government, the question would arise whether it would be better that it should be given to existing institutions of an independent character, or to create or maintain Government schools?—I think it would be in the first instance exceedingly desirable to provide it at what you call independent institutions. Some of them are old seats of learning, and others, although new, are well worthy to take their places along with those older seats of learning, and there are provided for already in some of those colleges a number of chairs that have been constantly filled by men of the highest eminence, where persons are in the habit of going to receive education, and where they do receive a first-rate education, and it would be a great advantage to have those additional branches, if they are to be taught, placed alongside of those that already exist where there is a most efficient staff of professors. It would depend upon whether or not those existing institutions might be found sufficient, and if not it might be worth the while of the Government to establish several new ones.

690. Upon what principle would you defend the existence of the present School of Mines, which I suppose we may regard as something beyond a school

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of mines, and rather as an institution for teaching experimental science?—I do not see why we should regard it as beyond a School of Mines. It was founded as a School of Mines, and though the title of the school for a time was unfortunately changed, experience showed that it was expedient to return to the old name of a School of Mines, and the subjects which have been taught there have always had special relation to mining, and other practical branches of knowledge of a cognate nature.

691. Will you say for example what Professor Huxley's chair is?—Professor Huxley's chair is Natural History and Palæontology, and Palæontology is quite an essential subject in a School of Mines.

692. Then in point of fact you look upon that school as chiefly a School of Mines?—As chiefly a School of Mines in the sense that the continental Schools of Mines are Schools of Mines. Many persons go to the continental schools of mining who have not necessarily anything to do with mining afterwards, but who go there for the kind of knowledge that is taught in them. Persons who wish to have to do with mines, engineering, and such subjects, will get a quantity of knowledge that afterwards may be turned to valuable account in their profession.

693. But so far as it is not solely a School of Mines it ranks simply with other independent institutions pursuing similar objects?—I cannot recognise it as not a School of Mines, for it is a School of Mines, and it was founded as such. The professorships now are the professorships that were established when it was founded with the view of being a School of Mines, and they have continued the same from that day to this.

694. And in practice the pupils are in the main persons who intend to devote themselves to mining pursuits?—Not necessarily. Some of them are, and some of them are not—as it is in other schools on the continent, they do not all go to learn mining, but they go, many of them, to attend the lectures of celebrated professors. Many persons who attended the lectures a year or two ago had no intention of ever being miners.

695. (*Professor Huxley.*) I gathered from what you said that in your judgment the want of accommodation for the survey very seriously impedes the operations of the survey?—Yes, it is excessively inconvenient, and it does impede them.

696. At the same time it is the fact, is it not, that the authorities have recently pressed upon you, and upon Sir Roderick Murchison the necessity of going on more quickly with the survey?—They have increased the number of surveyors very much, and increased them so rapidly that their method of doing it has been somewhat inconvenient.

697. What was the purpose of increasing the number?—To hasten the survey.

698. I gather from your observation that those gentlemen are rather tumbling over one another for want of room?—The want of room is so great that in the winter, when I call up a number of men from the country, I am obliged to set some of them to their work in their own private lodgings; they are under no superintendence at all, but they come to me at intervals to show me what they are doing.

699. (*Sir J. Kay-Shuttleworth.*) Could you furnish us with the date at which the Museum of Economic Geology was originally founded?—The museum must have been founded in 1838. It was before I joined the survey, which was in 1841.

700. Could you inform us at what period the Geological Survey of Great Britain was commenced?—I believe in 1834.

701. At what time was the School of Mines founded?—In 1851.

702. Looking to those successive periods and to what you have already said concerning the constitution and intention of the School of Mines, has that very obviously had a relation to the interests of mining throughout the country?—It has had a relation to it. The mining people of Cornwall and Devon and other

parts of England prepared a memorial and sent it to the Government praying for the establishment of such an institution, and among these gentlemen the late Sir Charles Lemon and Mr. John Taylor were prominent.

703. Could you furnish to the Commission a few of the more prominent facts illustrating the advantages which have been derived from the Survey and the School of Mines upon the progress of mining industry in England?—The most prominent is the publication of the maps of the Geological Survey, which have been, as miners acknowledge, of very great service to them, especially with regard to coal mining; for as most persons know, who know much about mining, all other kinds of mining, such as Lode mining, are founded on more uncertain data; but in the matter of coal mining and iron mining of a certain kind the data are much more certain; and the publication of maps of the coal fields, and of particular beds of coal, has been of very great service to miners. It has also shown the existence of coal fields underneath the Permian and Secondary strata in a way that was only half suspected before in a great number of cases. Since the establishment of the coal commission, the work done by the Geological Survey that will bear on the future mining prospects of the country will, in my opinion, be very prominently brought out. In the year 1845 I was appointed director of the Geological Survey of Great Britain, and by far the largest proportion of the survey of England and a considerable part of Scotland was entirely executed under my eye and direction. I held this subject that the coal commission has now in view all the time steadily in my mind, and a great proportion of the sections of the survey were planned with that view long before the coal commission was thought of. They have now become therefore of the greatest use, as the country I hope will see, when the reports of the coal commission are published, and that they will have a most important bearing upon the mining industry of the country.

704. So that in fact, the estimate of the probable duration of the supply of coal in this country will be very remarkably affected by the calculations arising out of the extension of the Geological Survey?—It will be very remarkably affected, and in other ways people will find out, that even in the now existing coal fields there is far more coal than is generally supposed.

705. Might I not also ask whether a very considerable portion of the work in the coal commission has not been effected by the skilled officers of the Geological Survey?—The gentlemen employed to investigate the quantity of coal that has already been mined out of the various coal fields, and therefore the quantity of coal remaining unworked in the coal fields, have been immensely assisted by the maps and by some of the officers of the Geological Survey. I mean by those gentlemen who are engaged under me in the practical surveying of the coal fields. Some of the Commissioners have declared that they do not know what they would have done without our maps, which form a groundwork for them to go upon.

706. So that I understand you to say, that in the first place, a scientific knowledge of the geological extent of the seams of coal underlying the Permian and Secondary strata, has been greatly developed by the Geological Survey, and that an economy in the exploration and working of the known coal fields has likewise resulted from that inquiry?—In several cases pits have been sunk through the Permian or in the New Red strata in consequence of information furnished by the maps and sections of the Geological Survey, and on the recommendations of the officers of the Geological Survey, and coal mines are now in operation and very profitably so, where those operations have taken place. The same kind of advice has been given in a great number of cases with regard to water supplies for towns, always given gratis to anyone that likes to come for information or advice, and with very good effect. In most cases the water has been found. In one case it happened to be salt, and therefore was of no use, but that was not the fault of



the man who predicted that they would get water at such and such a level. As to the economy, I am not in a position to answer the question; you must apply to the coal miners themselves.

707. A question was put to you, whether branches of theoretic science are not taught in what is properly denominated the School of Mines. Is it not clear that if you have to sink pits to the extraordinary depths which are now contemplated and to win coal under the Permian, you will probably need other means of ventilation, and means of reducing the temperature, which may require the application of high science?—I believe so.

708. And without which there would be an extraordinary waste of the abundant resources which would otherwise be attainable by the application of the highest theoretic science?—Yes, unless means of ventilation can be applied in that way by the application of theoretic science, a great quantity will never be won at all.

709. So that the operations of the School of Mines cannot be regarded as in any respect independent of the aid which can be derived from the highest resources of experimental science?—Certainly not, I consider that there is no good practical teaching which does not involve high theoretical teaching. In my own particular branch the best practical teaching in geology is the highest theoretical teaching.

710. You have described to the Commission the extraordinary defect in the means of teaching even theoretical geology in Scotland, and what admirable teachers of geology existed in the Universities of Oxford and Cambridge and in University College and King's College as the sources of information on theoretic geology in England; might I inquire whether abundant as those several resources in England have been for instruction in theoretic geology, you consider that that would render the existence of a separate school of mines unnecessary?—I do not think there is any other establishment where there is the same combination.

711. If you take the admirable teaching of Professor Sedgwick at Cambridge, or Professor Buckland and Professor Phillips at Oxford, would that instruction given in combination with other subjects to a student on scientific mining be likely to lead to such immediate practical results as in the combinations which occur in the School of Mines?—I think not.

712. To take, for example, the illustration which I have previously resorted to, of the winning of deep mines requiring the highest knowledge in other theoretic branches of science, do you think that if a practical student in mining had sought that geological instruction at Cambridge, he could have acquired at Cambridge under any circumstances all those other branches of knowledge which are necessary for the highest applications of theoretic science to mining?—I think very likely he might at Cambridge, because he would have the advantage of Professor Sedgwick's teaching in geology and Professor Stokes' teaching in physics.

713. But there is no professor of mining there?—No, that would be the one thing absent from it.

714. Nor generally in Cambridge is instruction in science taught experimentally?—I am not acquainted sufficiently with the curriculum of Cambridge to answer the question.

715. Some questions were put to you with reference to the degree in which the classes at the School of Mines are open to the public, and you advise that they should remain open to the public, but if it were regarded as important that some kind of guarantee should be obtained for a special class of students as, for example, for mining students, would you or would you not think it important that there should be a matriculation examination, and also other successive examinations leading up to the final result in the School of Mines?—I can only speak for my own subject. I have very rarely found anyone come forward who had not a sufficient amount of preliminary education to appreciate what I told him.

716. What have been the successive examinations in your own department of theoretical instruction for the Associateship?—I cannot answer that question. I know that they have to pass, but I do not know what number of examinations they have to pass for it besides geology; they have to pass geology, mining, natural history, and so on, but it is all published.

717. Generally you would subject a man to special examinations who had to obtain a degree or some form of degree?—A few do go through those examinations now, and very severe they are.

718. (*Dr. Miller.*) You were at one time Professor of Geology in University College, what number of lectures were you in the habit of giving then as compared with the course which you now give?—I think I gave about 25.

719. And about how many do you give now?—I give 36 or 38.

720. Supposing an endowment had been made to University College for the purpose of enabling lectures on geology to be given, is there anything which would have prevented you from giving the same kind of course at University College which you now give at the School of Mines?—At that time I think that I could not have done it. I could not have given the time at University College; the day was otherwise occupied.

721. I am speaking now as to the quality of the information?—There is no reason why, if a sufficient endowment were given, a gentleman might not give say the major part of his time to his chair in the way that other professors do.

722. Is it your practice at the present time to teach in the field?—No.

723. Your lectures are theoretical lectures upon geology now?—Yes. I sometimes take them out and give them an excursion or two.

724. Still after all it is in a great measure what must be called theoretical geology?—Yes.

725. What may have been the general average number of those who avail themselves of your lectures?—They have varied very considerably; I do not know how many. The largest number perhaps at the outside would be 40 or 45, and they would gradually diminish down to 25 or 30, or thereabouts, and so on. In the evening there are other lectures; there are two courses, one of which we are obliged to give to the working men every alternate year, and the other of which we are not obliged to give to people that pay; the working men pay 6d. for six lectures.

726. I am not speaking of those popular lectures, but the thoroughly scientific of course which you as the professor of geology have given there—that is 40, I think you say 40?—There have been as many as 50; but I think that must be the outside.

727. Do you see anything to prevent the establishment of a professorship of mining in connexion with such a place of instruction, say as University College or King's College?—I see nothing to prevent it if they can get the man and the money.

728. In fact if the Government had chosen to endow professorships in either these or any other similar institutions, you do not see anything against it?—Excepting the want of specimens.

729. And I suppose the Government, if it chose, might give the means for procuring them?—They might, but it would take them a very long time to find them; it would be a very difficult thing anywhere to establish a mining school with all the means and appliances that there are in Jermyn Street.

730. Truly, because there you have the national purse to go upon?—We have the national purse, and the best collections were made by the officers of the Geological Survey which they had an opportunity of making in a way that no other establishment could have, partly because of the number of men with a special knowledge to know what to select, and partly because it is their duty to do it, and they go all over the country to get them.

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731. I understand that the survey was originally quite independently established, and that this School of Mines has grown and been tacked on to it so to speak?—The museum was the first offshoot of the survey. It was a pity that the opportunity should be lost of collecting all the economic materials produced by the country when the survey was going on, and therefore they were collected, and at first placed in a small place in Craig's Court, and it developed until at length a larger museum was built, and it was considered at the same time, advisable to establish a school of mines in connexion with the Museum of Practical Geology, not in connexion with the Geological Survey, but in connexion with the Museum of Practical Geology. The Geological Survey is connected with the museum in so far as that its offices are there, and the museum is filled with specimens collected by the officers of the Geological Survey, and the selections are specially intended to illustrate the geology and Geological Survey of Great Britain scientifically, and all economic matters connected with it. Advantage of this happy state of affairs was taken to institute a School of Mines, having all the advantages that accrued from the establishment of the Geological Survey, and the Geological Museum, and the Mining collections in connexion with it.

732. As I understand you the difficulties of the survey would be relieved if the School of Mines did not live in the same building?—The difficulties of the survey would be much more satisfactorily relieved if they would add to the space, and not separate the establishments.

733. (Chairman.) Would your lectures as professor in the School of Mines differ in any important respect from the lectures which you would deliver as a professor in a university or in a college?—No.

734. An ultimate reference to practical chemistry would not materially affect the character of the school?—It would not.

735. Are your examinations *vivâ voce*, or on paper?—They are written entirely, but after every lecture I stay as long as anyone chooses to come and ask me questions, and that is better than any ordinary examination.

736. (Professor Huxley.) You were an officer of the survey at the time that the School of Mines was established, were you not?—Yes.

737. You will be able to state to the Commission whether what is here inserted in the introduction to the syllabus or prospectus of the Royal School of Mines is correct or not. "In the year 1851 numerous memorials praying for the establishment of a mining school were addressed to the Government by the leading representatives of the mining interest of Great Britain. The memorialists urged that though the value of the annual mineral produce of this country amounted to 28,000,000*l.*, equalling four-ninths of the total amount produced by the whole of Europe, and far exceeding that yielded by any other state, the miners and metallurgists of the United Kingdom were unable to obtain that instruction in the theory and the practice of their calling which had long been carefully provided for their foreign competitors in the mining colleges of France, Belgium, Prussia, Saxony, Austria, Spain, and Sweden, and the effect of which in all cases had been a marked increase in the economy, efficiency, and safety of mining operations." Is it within your knowledge that such was the origin of the School of Mines?—I perfectly recollect the circumstance.

738. Then it would appear to be proper to conclude that people very much interested in the mining interests of Great Britain having before them the universities, and having before them various private bodies, must have deliberately thought that it was very much better to go to the Government and ask them to establish this school?—Certainly, because there was not that combination of lectures in any way existing elsewhere.

739. And I think this statement further shows that

the establishment was not set up upon the motion of the Government out of any desire to interfere with existing bodies, but that it arose out of the representations of a very important and powerful commercial interest?—Certainly it did.

740. (Chairman.) Can you say whether there is any professor of mining in any institution in Great Britain?—I do not think there is, excepting in the School of Mines; certainly none in any of the universities that I know of.

741. Have you any means of knowing how many persons trained in the school of mines, are now employed in the mining industry of the country?—I have no means of knowing how many; there are a good number, that I know; a very considerable number have been employed in one way or another, and a number of them have been drafted off to the geological surveys of India and the Colonies. Many have risen to high distinction in their profession in that way. Others have been and are engaged in mining matters. Some of them have grown rich in consequence of the beginning of their knowledge being in Jermyn Street, and in one way or another some are occupied in connection with mines and great quarries and matters of that kind.

742. Have you often applications to recommend persons qualified to undertake the superintendence of any considerable mining industries?—I do not remember anyone applying for a person to take the charge of mines, although they have had the charge of mines having shown themselves capable some how or other of their own accord. There have been a number of cases in which persons have been applied for in connexion with works engaged in metals and that kind of thing in Sheffield and elsewhere and copperworks and ironworks, and so on. Many of the pupils of the School of Mines have gone directly from the School of Mines to fill appointments with very good salaries in such establishments, and they have done their duties well.

743. (Mr. Samuelson.) Have there been instances in which the pupils of the School of Mines have been profitably employed in industrial pursuits subsidiary to mining rather than in mining itself?—I am not prepared to say so. I have said that my knowledge did not enable me to answer the question precisely.

744. Did I understand you to say that you consider that the establishment of the School of Mines was fully justified by the representations of the persons engaged in mining industry at the time?—The Government considered it so.

745. But what is your opinion?—I did not take the trouble to consider the question. I considered that it was a very useful thing, but being a Government officer I did not choose to volunteer an opinion upon the doings of the Government in the matter.

746. If similar representations were made, or if similar considerations presented themselves with reference to the general industries of the country, would you consider that the Government were justified now in extending similar advantages to other branches of industry?—I should like to know what kind of teaching would be implied by that before I could answer the question.

747. A theoretical teaching having a bearing upon manufactures and civil engineering?—The civil engineers get it now, I believe. As for manufacturing industry of the common kinds, such as the hands engaged on common cotton manufacture, and weaving and so on, I do not see how scientific education could apply to such a subject, excepting that all education tends to develop intelligence.

748. What would you say about chemistry as applied to the industrial arts?—That is taught in every laboratory in the country now where there is a competent teacher, and competent teachers are very plentiful, much more so than there are in many other sciences. A great number of men go in for chemical education, and the present teachers all over the country turn out an amazing number of able young men.

749. But I understood you to say that the combi-



nation of sciences which it was desirable for persons to possess in order to follow industrial pursuits with the greatest advantage, was not found elsewhere than in the School of Mines?—I did not use the expression industrial pursuits, I said matters that were taught at the Schools of Mines over Europe.

750. But is the combination of studies, such as would be desirable for a person intending to follow an important manufacture or civil engineering found in any other institutions?—Yes, in the case of civil engineering I should think to a very great extent, but as for the kind of scientific education that may be required for the majority of manufactures, I know little about it, but I should think that a highly scientific education, though an advantage to any man, is not by any means essential to the majority of commonplace manufactures such as making combs and spinning, and anything of that kind, such as is done in a very large way in some of the towns in the north and middle of England.

751. (*Chairman.*) Have you any suggestions to make on any points to which none of the Commissioners have directed your attention, and can you furnish us with information which has not yet been elicited in your examination; for instance, could the public money be better applied than it is at present, or so as to produce larger and more immediate results?—No, I think there is as much money spent upon it as is desirable, and as many officers employed as is desirable at present, excepting that we should like exceedingly to have a practical chemist attached to the Geological Survey. The professors of chemistry connected with the School of Mines, that is to say, metallurgy and chemistry proper, are not bound to do work for the Geological Survey, and the result is that we have never had a chemist to do analyses for us.

752. (*Dr. Miller.*) But they receive 100*l.* a year each for this work, do they not?—Not that I know of, they are not bound to do it unless they are specially directed by the Director General. But the kind of work that is required would be of a constant character, occupying a man's whole time, and what I have always wished was, that I had a chemist attached to the Geological Survey, who would take his directions from the director, and would be bound to do, proximately what he wished him to do. The director knows what is required and a systematic set of inquiries could thus be gone into, with respect to analyses of rocks and minerals, and such like. This it has been impossible to get, ever since I have had anything to do with the Geological Survey.

753. (*Chairman.*) In that respect the Geological Survey is not quite up to the mark, which you think it might be?—In that respect it is not up to the mark, and that has been felt by every officer on the Geological Survey ever since I can remember. In Scotland and in Ireland we are equally at a loss.

754. What progress has the Geological Survey made, looking to the country as a whole?—I should think, roughly speaking, that England and Wales is about three-fourths done; Scotland is tolerably well advanced, but a prodigious amount remains to be done there yet, and the reason of that is, that the Ordnance Survey is still far behind in Scotland. The Ordnance Survey of England has only been finished this year; the last sheets have been published this year of the north of England, and the English branch, of which I take charge, is now within sight of Scotland; we can see the Scotch hills, and are working towards them. A good part of the east of England remains still to be done, but when we have finally worked up to the borders of Scotland, and joined on with the Scotch maps, the Geological Survey of England will not be completed, for the Government have determined to make us go back and survey all the coal mining districts over again on the scale of six inches to the mile. Lancashire and Yorkshire and all the country north of that has been topographically surveyed on a scale of six inches to the mile, and published. The geological survey lays down its lines on those six-inch maps, but south of

Lancashire and Yorkshire the scale of the Ordnance maps is only one inch to the mile, with some minor exceptions for strategical purposes. The mining proprietors of Flintshire and Denbighshire set the example of praying for a topographical map on a scale of six inches to the mile, the object of that being that the geological survey might come in after and resurvey that country, so as to give them the advantage for their mining work of the maps prepared by the geological survey on that large scale. Plain six inch maps are generally of no use to common mining men, for they rarely know how to use them or to lay the geology on them, or, at all events, they do not do it, they require the Geological Survey to come in and map their country properly for them. They represented to the Government, that they had only the old one-inch maps and that if they had maps on the six-inch scale, the Geological Survey might follow, and give them the geology on the scale of six inches to the mile. Staffordshire followed, and other coal measures districts have made the same representations. The Government therefore has ordered that all the areas containing coal fields, shall be re-surveyed on the six-inch scale, so that the officers of the Geological Survey may come in afterwards, and lay down the geology on that scale which shall be published for the benefit of the mining proprietors, and of the general public. Yesterday a gentleman, who is a large proprietor in Cornwall, spoke to me of the propriety of having the same thing done for Devon and Cornwall. He asked my advice as to the proper method of procedure, and I told him that the proper method of procedure was to do as the proprietors of the coal fields have done, namely, to have the matter brought before the attention of the Government, through their members of Parliament, as probably the most effective way, and also, if possible, he should have a conversation with Sir Henry James, the Director of the Ordnance Survey on the subject, and he said he would. And I foresee that all the country will be discontented, unless they get the Geological Survey on the scale of six inches to the mile, whether it is a mining area or not, for the farmers are becoming alive to the importance of geology with regard to their soils, especially now that the Geological Survey is beginning to prepare maps which do not merely relate to the rocky formations that underlie the surface soil, but also a set of maps for separate publication of all the superficial drifts, gravels, clays, and alluvia that form the actual soil of the country. There will therefore be when this is done two sets of maps one showing the rocks, and one showing superficial detritus that lies above the rocks, and only colouring the rocks on those latter maps where they actually rise to the surface; and they will be of value, the one set to the farmer, the landed proprietor, the draining man, and so on, and the other to all the mining and quarrying interests of the country. The Government hurry us on by way of finishing in our department; but I can see very well that I shall not live to see the end of the geological survey if the Government require us to re-survey the old ground on a six-inch scale.

755. (*Mr. Samuelson.*) But you approve of that, do you not?—I highly approve of it.

756. (*Chairman.*) Have any representations been made to you from the owners in mining districts of the insufficiency of the one-inch map for their purposes?—No special representations have been made, except from the North Wales coalfield. In the coalfields it will all be remedied in the long run, but when fresh ground is opened by miners we cannot move about from one part of the country to another, wherever a fresh mine happens to be opened, because it requires a long train of argument and reasoning to produce good geological maps; it is not mere measuring and exploration, and the better the geological maps are the more important they are to the mining men when the thing is really done. I mean the more scientific the geological maps are the more useful they are.

757. Are there any points in respect of which you would desire to make additions to your evidence?—

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17 June 1870.



A. C. Ramsay,  
Esq., LL.D.,  
F.R.S.

I do not think of any at present. I believe I have said everything that is of any importance, but if any-

thing occurs to me I shall be happy to put it down for the information of the Commission.

The witness withdrew.

17 June 1870.

*Additional remarks by Professor Ramsay.*—There are one or two points connected with the Geological Survey and the School of Mines which I should like to add to my evidence to show their utility. These two institutions have formed a school of geologists now largely engaged in geological work in distant countries. Sir William Logan, late director of the Geological Survey of Canada, worked along with the late Sir H. De la Beche on the Geological Survey in South Wales, and one of his assistants, Mr. Murray, was also trained on the English survey. Sir William established the Geological Survey of Canada as nearly as possible on the model of that in England. Mr. Selwyn, also trained on the English survey, directed the colonial survey of Victoria on the same principles, and several of his assistants were pupils of the School of Mines. He has since then succeeded Sir William Logan in Canada. Professor Oldham, Director of the Geological Survey of India, was formerly Director of the Irish branch of the British survey, and many of his numerous staff of assistants have either been trained on the British survey or educated at the Royal School of Mines. The Geological Survey of the Cape was conducted by Mr. Wylie, who was trained on the Irish branch of the survey, and the survey of Tasmania was directed by Mr. Gould, one of my assistants on the English survey, and an old pupil of the School of Mines. Mr. Wall, another old pupil, directed the Geological Surveys of Trinidad and Jamaica. The Colonial surveys and that of India have been undertaken at the request of the colonies themselves, and, under these circumstances, I cannot but think that their work has been of great value to the British Empire. In confirmation of this statement, I translate two passages which show the estimation in which the British survey is held by continental men of science of high repute.

In the year 1860 or 1861, Signor Sella, now Minister of Finance in Italy, and a distinguished mineralogist and man of science, was engaged on a mission to investigate the manner of working all the State Geological Surveys of Europe. In a report presented to Signor Commendatore Cordova, Minister of Agriculture, Industry, and Commerce, in 1861, he gives in detail the state of the Geological Surveys of France, the British Isles, Austria, Belgium, Germany, Switzerland, Canada, and the United States. The part that relates to Britain begins with the following statement, which I translate:—"England is undoubtedly the country where geological maps are constructed with much greater accuracy than in any other. The special importance of its mining industry, the diffusion of elementary geological knowledge, the zeal displayed by the geologists in charge, and the precision of their work, has resulted in this, that few undertakings of the Government have been more beneficial to the English public than the construction of the geological maps of the survey."

In like manner, M. Marcou, in a notice of the geological maps of Australia and Great Britain (Bulletin de la Société Géologique de France, 1867), observes "that this great and magnificent work, the Geological Survey of the British Isles, is by far the best of all those executed up to the present time in any of the countries of the old and new world." And again, "the organisation of the corps of geological engineers of Her Britannic Majesty is as perfect as the remarkable work which it has given to the scientific world." I call attention to these facts that it may be better known that in the opinion of dispassionate judges the money expended on the Geological Survey is bestowed on an object that elicits European commendation and helps to contribute to the honour of the country.

E. Frankland,  
Esq., Ph.D.,  
F.R.S.

EDWARD FRANKLAND, Esq., Ph.D., F.R.S., examined.

758. (Chairman.) I believe you are at the head of the Royal College of Chemistry?—I am.

759. And you are examiner in the Science and Art Department of the Committee of Council on Education, are you not?—I am.

760. Have you been an examiner for some years?—For three years.

761. Do you examine in any branches except chemistry?—Only in the two branches of inorganic chemistry and organic chemistry.

762. What is your opinion of the value of those examinations?—I think that they are taking great hold upon the country generally in the way of promoting the primary teaching of experimental science. I speak now, of course, only of my own department, with which I am specially acquainted.

763. Do the papers that are sent in to you lead you to the conclusion that a good deal of valuable information is obtained by those who are studying in the various schools of the country?—They do, and they more especially convey to me the impression that the quality of the teaching is improving from year to year. For instance, in the papers sent up this year there is a great improvement upon those sent up in 1869. It is evident that there is much more experimental teaching going on now than there was a few years ago. Many of the teachers are beginning to fit up small laboratories, in which they can experimentally instruct their pupils, and this has had a very beneficial effect upon the quality of the instruction imparted, and it also enables me to raise the standard of the questions considerably.

764. I presume that your students are classed in the same way as in other departments, an elementary class, a more advanced class, and an honours class?—They are.

765. I suppose that by far the greater number pass in the elementary class?—Yes, by far the greater number.

766. Are there a great number, however, in the advanced class?—Yes, a considerable number, and perhaps it might be well to give the numbers, as I have prepared a list of them. In the year 1868, which was the first year in which I held the office of examiner, the total number of papers worked was 904. Of those in inorganic chemistry there were in the easy series (for at that time the division was different from what it is now) 320, in the more difficult series 481, and in organic chemistry in the easy series 39, and in the more difficult series 64. Perhaps I may be allowed to read a short extract from my report: "As a general rule the writing was legible, but the spelling and grammar were, in not a few cases, very bad. The answers to the questions which involved some knowledge of analytical chemistry showed that very few of the candidates had had the advantage of laboratory manipulation. The subject of organic chemistry was obviously attempted only by the more advanced pupils, and consequently the answers to the organic paper displayed a more uniform proficiency than those returned to the inorganic paper. Some of the papers worked in organic chemistry were remarkably good, and indicated a considerable amount of careful and systematic reading." In 1869 the total number of papers worked was 2,386, viz., inorganic chemistry, honours paper, 53; advanced, 413; elementary, 1,707; making a total in inorganic chemistry of 2,173. Organic chemistry always attracts a much smaller number than inorganic or mineral chemistry, so that in organic chemistry we had in honours, 7; advanced, 45; elementary, 162; making a total of 214. I have no record amongst my notes of the rank taken by



the candidates in 1868. I believe that it was worked out at South Kensington, and that I did not assign the places of the students in the different classes, but in 1869 these candidates took rank as follows:—In inorganic chemistry in first class honours four passed, which was 7·7 per cent. of those that competed. In the second class 19 passed or 36·5 per cent., whilst 29 failed, or 55·8 per cent. In the first class of the advanced section 73 passed, being 17·6 per cent. 221 passed in the second class, being 53·5 per cent., whilst 119 or 28·9 per cent. failed. In the elementary stage 88 passed in the first class, being only 5·2 per cent. 394 passed in the second class, being 23 per cent., and 596 passed in the third class, being 34·9 per cent., and 629 failed, being 36·9 per cent.; and I would just mention that in 1869 there were three classes in the elementary stage, whereas now there are only two. Those are the results on the total number applying in inorganic chemistry in the three classes. In organic chemistry in the honours department in the first class no candidate succeeded in passing; in the second class three passed, or 43 per cent. of the total number. There were only seven that sent in papers in honours in organic chemistry, of whom three passed, so that four failed, being 57 per cent. In the advanced stage, the first class had nine successful competitors, or 20 per cent., and the second class 20, being 44·4 per cent., and 16 failed, or 35·6 per cent. In the elementary stage the first class was taken by four, which was 2·5 per cent.; the second class by 21, which was 13 per cent.; the third class by 82, which was 50·5 per cent., whilst 55 failed to pass, or 34 per cent. In my report I made the following remarks, "The honours questions were very difficult, and it is therefore not surprising that a large proportion of the candidates failed; nevertheless, several of the papers, both in inorganic and organic chemistry, displayed much accuracy of knowledge, and considerable acquaintance with the more important doctrines of modern chemistry, and the perusal of these papers has produced upon me the conviction that many of the candidates would have taken a higher position if more time had been allowed for answering the questions. Three hours are certainly far too short a time in which to do justice to the honours paper, either in organic or inorganic chemistry; and as a smaller number of questions or a less difficult paper would not satisfactorily test the candidates, I am of opinion that five hours ought to be allowed for answering each of these papers. This is the time allotted to similar examinations in the Royal College of Chemistry, and, I believe, in the London University. The chief defects noticed in the papers were obviously due to the want of efficient laboratory instruction in practical chemistry. No candidate ought to pass in honours who does not possess an accurate knowledge of both qualitative and quantitative analysis. The results of the examination in the advanced stage were more satisfactory than in either honours or the elementary stage, and they would doubtless have been still better had four hours instead of three been allowed for each paper. The chief defect noticeable, and it is a very serious one, was the almost universal ignorance of systematic qualitative analysis. Nearly all the candidates knew something of testing for individual elements and compounds, but they were quite ignorant that many of these tests were inapplicable when other substances were present in the material tested. The smattering of analytical knowledge which they possessed was worse than useless, because, if applied, it would certainly lead them astray. It was also evident that the candidates had depended too much upon mere book work and oral instruction; they had not been sufficiently brought into contact with the phenomena themselves through the aid of experimental illustrations, performed either by them personally or by their teacher. *Elementary stage.* The separate files of papers returned in this as well as in the advanced stage, exhibited the widest differences as regards proficiency." I may mention that

those files, I believe, represent the different schools, or the pupils under different teachers, and if so, that is rather an important fact about them. "In some files nearly every paper was good, if not excellent; in others nearly every candidate failed. How far this depends upon the comparative efficiency of the teachers of different classes, and how far upon the aptitude of the pupils or the time they can devote to the subject, I have no means of ascertaining; it can scarcely be doubted, however, that an inquiry into the cause or causes in certain typical cases would throw considerable light upon the mode in which chemical instruction is now being given in the science schools throughout this country. Judging from the manner in which certain of the questions" (and I referred to Nos. 5, 7, and 11, and I will leave copies of those questions with the Commission if they please) "were answered by a very large number of candidates, I cannot avoid the conclusion that nearly all their knowledge was acquired from books, or from lectures with exceedingly meagre experimental illustrations. The pupils seem to be retentive enough, as evinced by the answers they have given to two questions for which they were evidently well prepared. On the whole, however, the results of this examination have convinced me that oral primary chemical instruction has made great advances since May 1868; but, as I have already mentioned, they exhibit a great deficiency, if not total absence of practical instruction in the schools reached by the advanced and elementary papers. So long as this instruction is not imparted, the chemical knowledge acquired by the pupils will be likely to be superficial, and it will certainly be of but comparatively small practical benefit to them in after life. Practical instruction in which the pupil is made an operator is by far the most valuable kind of chemical teaching. It serves to give solidity to what has been learnt from books and lectures, and it is directly applicable in the every day operations of the workman and manager. But how is this instruction to be imparted to the class of pupils presenting themselves in the elementary and advanced examinations? I have carefully gone into the cost of giving such instruction, and find that its minimum amount (for chemicals used and apparatus broken) would be 2*l.* for each pupil. It is obvious that, except in very few cases, the pupil himself cannot pay this sum, still less can the teacher of numerous pupils be expected to make himself responsible for it. It seems therefore that a considerable proportion of this sum must come from some source outside the school, and until some provision of this kind shall be made it will be useless to ask such questions as 'a.' in organic chemistry, and 'e.' and 'g.' in inorganic chemistry," questions requiring this kind of experimental knowledge. "In view of the great importance of analytical chemistry, it is greatly to be desired that a first class in the advanced stage should only be obtainable by those who exhibit such a knowledge of qualitative analysis and of practical chemistry as will enable them to answer questions like those just alluded to, but the cost of imparting such instruction makes me hesitate to recommend such a regulation." The Lords of the Committee of Council on Education have since passed a minute in conformity with the above recommendations authorizing the payment of 2*l.* per student, extending over two years, towards the expense of chemicals and perishable apparatus, but this minute took effect too late to exert any direct influence upon the examinations in May 1870. It was only passed, I think, about the middle of March, and certainly was not known in time to produce any effect directly; it had, I believe, some indirect effect, because it was talked about for nearly a year previously. Now we come to the present year, 1870, when the total number of chemical papers worked was 2,925, viz.: In inorganic chemistry in honours there were 51 candidates, advanced 372, elementary 2,268, making a

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17 June 1870.

total in inorganic chemistry of 2,691. In organic chemistry there were in honours 7, as in the previous year, advanced 35, and elementary 192, making a total of 234. These candidates took rank as follows:—Inorganic chemistry, honours first class 8, or 15·7 per cent. Second class 13, or 25·5 per cent., whilst 30 failed, or 55·8 per cent. In the advanced first class 20 pupils passed, or 5·4 per cent.; in the second class 192, or 51·6, whilst 160 failed or 43 per cent. In the elementary stage there passed in the first class 681, or 30 per cent.; in the second class 1,023, or 45 per cent., whilst 540 failed, or 25 per cent. In organic chemistry, in first class honours no student took a place, not one came up to the standard; in the second class three passed or 42·9 per cent, and four failed, or 57·1 per cent. In the advanced stage in the first class 11 passed, or 31·4 per cent.; in the second class 18, or 51·4 per cent., and six failed, or 17·2 per cent. In the elementary stage in the first class 85 passed, or 18·2 per cent.; in the second class 101, or 52·6 per cent., and there failed 56, or 29·2 per cent. "A comparison of the results of the examinations in May 1869 with the above, shows that the higher classes of chemical students have not, as a body, been attracted to these examinations. The number presenting themselves for examination in honours in 1869 was 59; in 1870 it was 58. On neither occasion did any candidate gain a first class in organic chemistry, whilst in each year only three obtained a second class, and four failed to pass in this subject. Again the students presenting themselves for examination in honours in inorganic chemistry were nearly the same in both years, but although the proportion passing in the first class increased from 7·7 per cent. in 1869 to 15·7 per cent. in 1870, still a larger proportion failed to pass in 1870 than in 1869; for in 1869 55·8 per cent. failed, whilst in 1870 58·8 per cent. failed." That is on the total both of organic and inorganic. "It must not, however, be concluded from these numbers that the candidates for honours have on the whole deteriorated; on the contrary, the papers worked in 1870 were decidedly superior to those sent up in 1869, but in 1870 a knowledge of qualitative and quantitative analysis was made a *sine quâ non* to the attainment of a class in honours in inorganic chemistry. The long continued exclusively literary training which has obtained in our schools and colleges, makes both teachers and pupils slow to learn that a training in experimental science does not contemplate merely the reading and committing to memory of the thoughts of others, but much more, an actual contact of the student with the phenomena presented by the objects which surround him. Hence the large proportion of failures when this kind of knowledge is exacted. Both the number and quality of the candidates for honours are doubtless also affected by the regulation, 'No payment is made on account of students taking honours,' which was in force until recently," and which is now abolished, 4*l.* each for students who pass in the first class, and 2*l.* for those in the second class, being now offered.

767. (Dr. Miller.) Is anything now paid for the expenses of those who do not pass in experimental chemistry?—No. "Similar conditions affect, though in a mitigated degree, the pupils who come up in the advanced stage; thus, 'No prizes are given to a student, however well he may do in the advanced paper, unless he has passed the elementary before, and no payment is made to the teacher.' I most cordially agree with this recommendation, but it doubtless tends greatly to restrict the number of candidates. We find, in fact, that the number of candidates in the advanced stage of both organic and inorganic chemistry fell off considerably in 1870 as compared with 1869. But whilst the number of candidates has decreased the quality of their work manifests a most satisfactory improvement in the inorganic branch, as is seen from the following comparison:—

"Of 100 candidates in the advanced stage of organic chemistry in 1869 there passed in the first class only 20·0, and in the second class 44·4, whilst 35·6 failed. In 1870, on the other hand, no less than 31·4 per cent. passed in the first class and 51·4 in the second, whilst only 17·2 per cent. failed. Unfortunately this improvement is more than compensated for by a decided deterioration in the answers returned in the inorganic branch, for in 1869 17·6 per cent. passed in the first class, and 53·5 in the second, whilst only 28·9 per cent. failed. On the other hand, in 1870 only 5·4 per cent. passed in the first class, and 51·6 in the second, whilst no less than 43 per cent. failed to get a class at all. It must be observed that the questions were more difficult in 1870 than in 1869. Nevertheless, after making due allowance for this circumstance, I cannot avoid the conclusion that on the whole the candidates presenting themselves for examination in the advanced stage of inorganic chemistry in 1870 were inferior to those coming up in 1869. Moreover, I can scarcely doubt that many of the candidates in the elementary stage last May would have done much better in the advanced stage than many who attempted the latter; indeed, the great success of the elementary candidates in May last encourages me to hope that many of them will, in conformity with the regulations of the department, present themselves in the advanced stage next year, in which case my report in reference to this stage will doubtless be of a much more satisfactory character. As just intimated, it is a comparison of the results attained in the elementary stage in 1869 and 1870, which exhibits the work of the science teachers throughout the country in the most satisfactory light, and affords indubitable evidence of the very substantial advance which has been made in the quantity, and still more in the quality of the primary chemical teaching throughout this country. The numerical results of the two years in this stage are not strictly comparable, because in 1869 the successful candidates were divided into three classes, whilst in 1870 they were comprised in only two, but if we throw together the first and second class of 1869 and compare the aggregate of these two classes with the first class of 1870 (a proceeding obviously unfair to the results of 1870, inasmuch as 56 marks per cent. secured a second class in 1869, whilst 70 per cent. were required to attain a first in 1870) the results are very satisfactory. In the first place, the number of candidates in 1869 was 1,869, whilst in 1870 it was 2,460. In 1869, 28·2 per cent. passed in the first and second classes (only 5·2 per cent. in the first) in inorganic chemistry, and 34·9 per cent. in the third, whilst no less than 36·9 per cent. failed. In 1870 30 per cent. passed in the first class, and 45 per cent. in the second, whilst only 25 per cent. failed. Again, in organic chemistry in 1869, only 15·5 per cent. passed in the first and second classes (only 2·5 per cent. in the first) and 50·5 per cent. in the third class, whilst 34 per cent. failed; but in 1870 18·2 per cent. passed in the first class, and 52·6 per cent. in the second, whilst only 29·2 per cent. failed. One of the most gratifying things about this section of the results of the examinations of last May is a very decided improvement in the knowledge of analytical and experimental chemistry, on the deficiency of which I had to comment so strongly in my reports of 1868 and 1869. Much still remains to be done in this department of chemical teaching, but it is very satisfactory to find that so much progress has been made even before the minute in aid of laboratory teaching above alluded to had come into operation. As the minute had been talked about during the year, however, it probably produced some effect in anticipation. Through these payments by the Science and Art Department for chemicals and apparatus I anticipate a further great improvement in the knowledge of practical chemistry next year, especially as this branch of chemical teaching will



"receive an important stimulus from the instruction of 120 teachers at the Royal College of Chemistry next month. A very large number of the papers, both in this and the other stages, were very satisfactorily worked, and altogether the results of the last examination have left upon me a strong impression that there is now being given throughout the country a large amount of fairly sound and painstaking primary instruction in chemistry." Those are abstracts from the three reports that I had to make.

768. (*Chairman.*) Are the Commissioners to understand that no candidates can go in for the advanced examination who have not passed the elementary examination in the previous year?—They can go in, but the teachers can receive no payment, and the candidates themselves cannot take prizes, except the Whitworth scholarships, and their teachers receive no payment for those; therefore the teachers use their influence, of course, to induce them to go in for the elementary paper first.

769. Do you think it advisable that the regulation that the candidates should pass in the elementary examination previously should be continued?—I think so.

770. Does the same rule apply to honours; must they have passed in the previous stages?—No, there is no regulation about the honours examination; anyone can go in for that.

771. The proposed grant of 2*l.* per pupil to each teacher for the means of teaching experimental chemistry has not yet come into operation, has it?—Yes, it has now come into play.

772. But it had not come into operation before the last examination?—Only about a month before the examination; its adoption was scarcely known to the teachers.

773. Are they entitled to ask for that 2*l.* per head for the results of the last examination?—No, not for that; at least I do not read the minute so. I will put in this minute, which is dated April 1870, with regard to the question that Dr. Miller asked a little while ago: "The present grants for apparatus are confined to such objects as are of a non-destructible nature, and therefore do not meet any of the expenses to which a student is put in a course of chemical analysis in materials and in the lighter breakable articles. To aid students in defraying some portion of the cost, My Lords determine that after the next examination a payment of 1*l.* shall be made towards the expenses of a student in the laboratory for a year, on condition that: (a) The school is reported to be furnished with a laboratory sufficient for the purpose, and fitted up with all the apparatus given in the official list. This list will be furnished shortly. (b) That the student for whom the payment is claimed receives at least 25 lessons of not less than one hour and a half each in laboratory practice: (c) And that he passes in the elementary or in the advanced stage of inorganic or organic chemistry."

774. (*Dr. Miller.*) Is there any grant besides that for the maintenance of the laboratory?—Yes, 50 per cent. upon the price of certain kinds of apparatus specified in the list.

775. (*Chairman.*) You have no means of knowing how many teachers undertake to teach chemistry without having any means of furnishing laboratory instruction?—Personally I have no means of knowing that; but official inspectors visit the different schools, and, I presume, report on this point to the Department.

776. You do not think that any really valuable information can be obtained without it?—I do not, and the teaching of chemistry becomes very much a matter of cramming if it is not accompanied by that kind of instruction.

777. Should you be disposed to recommend that no teacher should be allowed to teach chemistry without having the means of giving experimental and laboratory instruction?—I would not lay any direct prohibition upon the teaching of chemistry at all, but I would, by so framing the questions, prevent pupils obtaining

a first class in the advanced stage without this knowledge.

778. (*Mr. Samuelson.*) I believe that last year a number of teachers came up to the laboratory in Oxford Street in order to receive instruction in laboratory practice and the method of teaching?—Yes, they did in the first week in July; there were about a hundred of them.

779. What proportion would that be of the entire number of persons teaching chemistry in connexion with the department?—I suppose it would be only a very small proportion, and I may mention that the majority of the 100 were not chemical teachers, or had not been up to that time chemical teachers at all. In fact I presume the majority have not even since been chemical teachers; but of those 100, 26 received a week's practical instruction in the laboratory after a lecture which I gave to the whole hundred, and it was this practical instruction in the laboratory which I believe had some effect in promoting laboratory instruction throughout the provinces during the year.

780. Of the entire number of teachers who gave chemical instruction in connexion with the department only 26 obtained this laboratory practice, which practice was only of one week's duration?—Only of one week's duration.

781. Do you know upon what principle selection was made of the teachers who came up?—Yes, those who had some previous knowledge of chemistry were selected for laboratory practice.

782. But that teaching brought you into personal contact, did it not, with many of those engaged in conducting classes?—It did more especially with the 26 that I have mentioned who were under my direction for a week.

783. Will you state what your general impression was as to their capacity for teaching and their preparation for teaching?—With very few exceptions indeed they were entirely unprepared for teaching practical chemistry at that time; they were exceedingly grateful for the instruction afforded them, and many of them remarked that if they could have a training of that kind for two or three months they should be able to teach in laboratories of their own with success. They certainly made very good progress in that week, and in the cases where there was a previous knowledge of theoretical chemistry I have very little doubt that three months would go far to enable them to do it.

784. You have no accommodation that would enable you to comply with such a request?—No, we could not do it at present; we have not room for it. There is another proposition; in fact I believe it has already been determined upon to have 120 chemical teachers up again this year, and they are to come, I believe, in the first week in July, and they are to have, in sets of 40, a week's training in the college; that is to say, we shall have 40 in each of the first three weeks in July, making 120 altogether, and the whole 120 will be in town together in the second week, so that I can give to the whole of them a course of six lectures in the second week.

785. And that you consider to be a decided step in the right direction?—It is a step, but it is a small step obviously; a week's training is only a very small amount, but my laboratory is quite full of regular students until the last day in June. Our vacation begins on the 1st of July, and we shall sacrifice nearly the first month of it; therefore it is obviously impossible for us to go much further with our present accommodation.

786. Have you considered the question of giving a systematic training to the teachers of elementary classes throughout the country?—Yes; that has been often forced upon my notice from attempts of this kind having been made, and from the complaints of teachers in London with whom I sometimes come in contact, of the want of such instruction, and the gladness with which they would receive it.

787. Do you know what steps, if any, are contemplated by the Department to give effect to the desire

*E. Frankland,  
Esq., Ph.D.,  
F.R.S.*

17 June 1870.







the first elementary experiments that his teacher would show, and he obviously knows nothing about it, that is to my mind nearly a conclusive proof that he has not seen experimental illustrations at all.

807. Would the answer to such a question as you just now describe, enable you to form any rough estimate of the proportion of scholars who had received simply book instruction, or who had received theoretical instruction in combination with some practical teaching?—Unfortunately I have not made a sharp separation between, on the one hand, those papers that were worked by the candidates who had obviously not been instructed practically, and, on the other, those who had, and consequently I could not furnish the Commission with any definite numbers; it is only a general impression left upon my mind from the perusal of all those papers; and further, I may say, that according to the regulations of those examinations, I only see about 20 per cent. of the elementary papers myself; the assistant examiners alone have to work the rest, so that I have only the 20 per cent. actually before me; of course I got the assistant examiners' reports as well, and they are also very strong upon that point, therefore I presume they have noticed the same thing.

808. Therefore, the inference is that the number of those who receive practical instruction is small?—Yes, it has been so till last year, but I think it is very much larger in the year 1870 than it was in the year 1869.

809. Did I rightly understand you to say that in respect to chemistry, theoretical instruction without practical instruction is peculiarly defective?—Certainly, and it is practical instruction which is peculiarly defective. Theoretical instruction alone is not of much value, and it would very soon disappear from the mind.

810. Of course you are very well aware of the history of certain remarkable self-educated men, who have made singular contributions to industrial chemistry, such as the history of John Mercer, to whom the calico printing of this country is so much indebted. Taking such exceptional phenomena as the history of those men exhibits, do you think that the elementary instruction that is now given to the country is likely to afford facilities which it would be unwise to abandon with regard to such men?—I think undoubtedly it must be so. Men of that class would be certain to be brought up to the surface, and consequently this kind of instruction, if supplemented by a higher education in experimental science, must have the very deepest influence upon the progress of a nation like ours. You may count almost upon your fingers the names of the men who have greatly influenced the position of this country, and, indeed, of the world, at the present time with regard to manufactures, and inventions of all kinds, and consequently if you can only, by the cheapest process you can devise, sift out and separate such men, and bring them up to their proper position at the surface, it is worth a great deal of trouble, and worth the incurring of a great deal of expense to do this; and as these exceptional men contribute greatly to the wealth and prosperity of the nation, the cost of finding and educating them may, in my opinion, be fairly charged to the nation.

811. At the same time you will bear in mind that the efforts of John Mercer, whom I will take simply as an example, were at a very early period associated with the practical application of such theoretical knowledge as he had obtained to industrial purposes and I believe he created for himself a laboratory, however rude?—Yes.

812. In fact, I may take for granted from what you have said that you would conceive that such a man would have been wonderfully assisted if there had happened to be a good mechanics' institution, or other secondary school with a good laboratory at his command, and scientific instruction in manipulation?—I think there cannot be a doubt of it, and, moreover, there are probably many such men as John Mercer who have never had any opportunity of developing their talents, who have been kept out of their proper spheres from

the want of instruction of this kind. That is what I more particularly mean when I say that an opportunity should be given to a man of that kind to make his talents known, so that he may be put in the way of the necessary education for the development of those talents. It is scarcely likely that Faraday, for instance, would ever have been heard of, had not Sir Humphrey Davy taken him by the hand; and it is melancholy to think how many valuable men like Faraday are, in all probability, under our present system, lost to the nation.

813. Might I presume that you have some such combination as this in your mind, that there should be such elementary classes as exist now for giving book instruction, and that they should receive encouragement, and that there should likewise be efforts to develop in such institutions as mechanics' institutions or other secondary schools the means of laboratory practice?—Yes, I think that would be very desirable. I think one ought not to discourage any kind of instruction in science. It has been so neglected that it cannot, I think, at present perhaps be tried in too many ways and in too many places as a means of instruction, but I would provide, as you suggest, that this instruction should afterwards be carried on under better and under more auspicious circumstances in institutions where the highest kind of instruction is imparted. These institutions would then be supplied with young men selected for their intellectual powers from the whole community, and the highest instruction could then be given with success.

814. You are very well aware of the state of the colour shops, and other chemical laboratories of the various industries, the dye works, and the chemical works of the country, and I think I may appeal to you whether in many cases there has existed an opportunity for acquiring anything like a scientific knowledge of manipulation by the processes in those colour shops or other laboratories?—I should not think that it would be possible in those rude laboratories; and the purely technical and empirical operations are there of a kind that are almost inconsistent with teaching at the same time.

815. They are for the most part traditional processes conducted with very little theoretic knowledge, and often very rudely?—Yes, the people who guide those processes in the colour-mixing shops are generally uneducated men, who have no notion of the chemical changes which take place, and who go merely by the rule of thumb.

816. The cases of shops, like Mr. Thompson's, of Primrose, and others with which you are familiar, are quite an exception to the ordinary phenomena of trade, are they not?—Certainly.

817. So that in connexion with even the most successful and extensive works, the laboratories, so called, or colour shops more properly called, of those works are not conducted on scientific principles?—I should say not in any one case probably.

818. Would it not be a great advantage to the development of the industry of the country that there should be a gradual introduction of more scientific methods into such laboratories and colour shops?—I think it would be very desirable. I believe that processes may be greatly cheapened in that way; and the productions of the workshop may be also made more permanent, more valuable, and more applicable to the purposes for which they were designed than they are at present, if the managers more especially, but also the workmen, were better instructed.

819. Have you any means of knowing the comparative condition of such colour shops and industrial laboratories, for example, in France and in England?—I may say that I have no practical acquaintance with the corresponding places in France.

820. Take Switzerland?—Nor Switzerland either. My knowledge is all hearsay on this subject on the continent.

821. But judging from the condition of the industrial products of those countries, the delicacy of the tints in calico printing, and the dyes in the dyeing of

*E. Frankland,  
Esq., Ph.D.,  
F.R.S.*

17 June 1870.



E. Frankland,  
Esq., Ph.D.,  
F.R.S.

17 June 1870.

silks and woollens and cotton, would you or would you not suppose that in the production of objects of the highest luxury there must be advantages obtained in France which are not yet obtained in England?—I believe there is not a doubt about it that there are refinements in the arts of dyeing and calico printing that are now, or at least in the first instance were, discovered in France and in Germany and in Switzerland, which are only gradually introduced into this country, and we are therefore dependent upon those countries for them. I will not say that there are not other discoveries that are made here that are also in their turn taken into those countries, but I believe that the balance in that way is against us considerably.

822. Are you not aware that in some of those chemical and dye works in England, in which the greatest progress has been made in the rivalry of foreign countries, advantage has been taken of the scientific knowledge of workmen who have been introduced into this country for the purpose of being put at the head of such colour-shops?—Yes, there are cases of that kind; some of the most renowned calico printers have paid particular attention to the scientific department of their manufactures. I would instance Messrs. Hoyle and Sons, who are renowned throughout the world for the fastness of the colours that they produce; they have always had associated with them a gentleman usually as partner, but in the first instance frequently as a chemist—they have had associated with them a man who was thoroughly conversant with chemistry, and could bring his knowledge to bear upon their processes, but still, even in that case, he could do so only to a limited extent, on account of the ignorance of the managers and workmen under him.

823. Has not a very large fortune been made by the most successful Turkey-red dyer in this country, Mr. Steiner, of Accrington, who acquired his early knowledge abroad and brought it to this country, and worked upon the basis of that knowledge in developing the industry of this country?—Yes; in fact Mr. Steiner brought to this country a process which almost revolutionised the dyeing trade, inasmuch as he taught us how to recover, from what we had turned into our rivers as spent madder, a quantity of dye still in it about as great as that which we had already used out of it.

824. May I not also infer that Mr. Steiner's works had during his very long life been more conducted on scientific principles than those of any other dyer in the trade?—I should think so. I never had the good fortune to go through Mr. Steiner's works, but I was well acquainted with Mr. Steiner, and also with his partner, Mr. Gatty, who is also a foreigner, and an excellent chemist; so that in fact there were two scientific men connected with those works. Mr. Gatty I think first joined Mr. Steiner as a chemist in the works, but he afterwards became a partner, and he has made many important improvements in the process of Turkey-red dyeing, and also in other departments of dyeing and calico-printing.

825. Then one of the consequences of the introduction in a single instance of the scientific management of such colour shops and dye works is, that it operates as a school likewise for the workman, and that the manufacturers of the country incidentally benefit from them. I do not know whether you are aware that offshoots of Mr. Steiner's works have been established, and that there are many Turkey-red dyers who are using the processes which he introduced?—I am not aware particularly of that being the case with reference to Mr. Steiner, but I do know that it is so with regard to Messrs. Hoyle and Sons, of the Mayfield printworks, Manchester. There was, in the first place, Mr. John Graham, who established another work away from the original one; and then there was Mr. Thom, who is a most successful calico printer, near Chorley, at the present time; both these gentlemen derived their knowledge from the laboratory of the Mayfield printworks. And I may here remark

that the late Alderman Neild, at that time the senior partner in these works, was so impressed with the great importance of chemical training for the development of the calico-printing industry of Manchester, that he laboured hard and successfully for the establishment of a chemical professorship and laboratory at Owens' College. At first it was contemplated to make that college an institution for purely literary and mathematical training; but the strong representations of Alderman Neild, himself a trustee of Owens' College, had the effect of inducing his colleagues to add chairs of chemistry and natural history to those of languages and mathematics.

826. All which acts are illustrations of what I am desirous to bring out from your testimony that the introduction of scientific processes into colour shops, as they are ordinarily called, and the laboratories of our various industries and dyeing and calico printing, is of importance to the economic industries of the country?—I think there is no doubt whatever that the progress of those arts depends essentially upon the bringing of scientific knowledge to bear upon them. It must either be done in this country or elsewhere, and if we do not do it we are behind in the race of competition, because naturally we come after the inventors of those processes have reaped the greatest profit from them.

827. The truth being that we have been exhausting the idea of cheapness of production in this country by means of machinery and the other forms of reduction of cost, but on the other hand we have been to a very great extent neglecting the scientific processes by which the highest luxury and skill in production can be obtained?—Yes, I think we have cultivated the rough and ready mode of manufacture more than the refined in this country.

828. (*Dr. Miller.*) With the scale of rejections that you adopt in your examination, have you any scale below which no one is allowed to pass?—Yes; in the advanced stage they pass if they obtain over 39 per cent. of the total number of marks; they must get over 39 to pass, and in the elementary stage they must get over 29: they must get 30 marks.

829. (*Chairman.*) Have you visited any of the schools of science in the country?—I have visited a number of the principal ones, but not many of the smaller schools from which many of these elementary candidates are sent up to the examinations. Of course I know all the large science schools—Owens' College, the Midland Institute of Birmingham, and so on, and a few science classes, such as the classes in mechanics' institutions in Lancaster, Preston, and some of the other towns of Lancashire.

830. Several in which a very considerable amount of chemical knowledge can be acquired?—Yes, undoubtedly.

831. And there they approach the advanced description?—Yes.

832. (*Mr. Samuelson.*) You spoke of the necessity for those employed in industrial pursuits having a scientific knowledge of chemistry, and you stated that, where the managers and directors of those works were men of scientific attainments, the difficulty still remained of the workmen being uninstructed; have you any knowledge of the relative state of instruction of the workmen employed in similar works in England and in France?—I have more particularly in Switzerland and in Germany than in France. In Switzerland and in Germany the education of the workpeople is very much superior to what it is in this country, and as a consequence it is possible to carry out processes of a delicate nature in manufactories there that I believe could not be attempted in this country without almost the certainty of loss or failure altogether.

833. But the illustrations which were given were chiefly by comparison between similar processes carried on in England and in France?—Yes.

834. You are perhaps not aware that the state of instruction, both elementary and scientific is equally



low amongst the working population in France as it is in England?—I was not aware that it was equally low. I thought it was not so high as it is in Germany and Switzerland by a good deal, but I did not know that it was equally low with England. Indeed, on my first visit to France, in 1848, I found a well-known professor giving experimental instruction in chemistry to the workmen of Rouen on a Sunday afternoon.

835. But however that may be, would you not, in an industrial point of view, attach greater importance to a high standard of cultivation on the part of managers than to some improvement in the average instruction of the workmen employed?—I think, if you are offered the alternative of the one or the other, certainly the instruction of the managers would be very much to be preferred.

*E. Frankland,  
Esq., Ph.D.,  
F.R.S.*

17 June 1870.

The witness withdrew.

Adjourned to Tuesday next at 11 o'clock.

## EXAMINATION PAPERS HANDED IN BY PROFESSOR FRANKLAND.

1869.

### QUESTIONS REFERRED TO IN THE ANSWER TO QUESTION 766.

No. 5. If a mixture of manganic oxide (peroxide of manganese) and hydrochloric acid be heated, what chemical change takes place? Give the name and properties of the gas which is evolved.

No. 7. You have given to you zinc, sulphuric acid, caustic potash, and water, and are required to prepare hydrogen from these materials by two distinct processes: state how you would proceed, and show by an equation the chemical change in each case.

No. 11. You have some mercury, a glass flask, and a piece of hard glass tube, and are required to make pure oxygen gas: how will you do it?

*a. In Organic Chemistry.*—How would you perform the analysis of an organic body containing carbon, hydrogen, nitrogen, oxygen, and sulphur?

*e. In Inorganic Chemistry.*—How would you perform the qualitative analysis of an alloy containing arsenic, copper, silver, lead, and iron?

*g. In Inorganic Chemistry.*—You have given to you dipotassic dichromate (bichromate of potash), ferrous sulphate (protosulphate of iron), alcohol, ammonia, hydrochloric acid, water, and baric chloride (chloride of barium), and you are required to make from these materials, chromic chloride (sesquichloride of chromium) and ferrous chloride (protochloride of iron): how will you proceed?

## PAPERS FOR MAY 1870.

### SUBJECT X.—INORGANIC CHEMISTRY.

Examiner, Professor FRANKLAND, Ph.D., F.R.S.

#### GENERAL INSTRUCTIONS.

You are only permitted to answer questions from the elementary paper or from the advanced paper, but not from both. If the rules are not attended to, the paper will be cancelled.

In all cases the number of the question must be placed before the answer on the worked paper.

*Three hours are allowed.*

#### FIRST OR ELEMENTARY STAGE EXAMINATION.

You are only permitted to attempt *eight* questions. You may select these from any part of the paper.

The value attached to each question is the same.

You are requested, whenever possible, to express the reactions in equations.

You are to give such numerical details as will show the mode of calculation.

1. Explain how you would demonstrate experimentally that water is formed by the combustion of hydrogen in air.

2. What is meant by the atomicity or equivalence of an element? Give the atomicity of all the non-metallic elements.

3. What do you understand by the terms "element," "oxide," "metal," and "non-metal"?

4. One litre of nitrogen gas, measured at 0° C., and 760 m.m. mercurial pressure, weighs 14 criths; what is the weight in grains of one cubic metre of the same gas measured at the same temperature and pressure?

5. Mention the composition of ozone, state its properties, and describe how you would prepare it.

6. How would you demonstrate experimentally the composition of water and of air?

7. Classify the following substances into elements and compounds:—

Epsom salts	Calomel	Iodine
Copper	Nitre	Lead
Bronze	Tin	Brass
Chalk	Graphite	Diamond.

8. Give the names of the substances denoted by the following chemical formulæ:—

OH <sub>2</sub>	HCl	Cl <sub>2</sub>
N <sub>2</sub> O <sub>5</sub>	B <sub>2</sub> O <sub>3</sub>	HO <sub>2</sub> Cl
O <sub>3</sub>	SO <sub>2</sub>	NH <sub>3</sub>

9. Give the symbolic formulæ of the following substances:—

Water	Carbonic anhydride
Perchloric acid	Sal-ammoniac
Sulphuric acid	Boric anhydride
Ozone	Hypochlorous acid.

Hydroxyl

10. What is the specific gravity of ammonia, that of hydrogen being taken as unity?

11. How would you show experimentally that hydrochloric acid consists of hydrogen and chlorine?

12. I add two volumes of oxygen to one volume of each of the following gases: what takes place, and what effect will be produced if an electric spark be afterwards passed through each of the mixtures?—

Chlorine	Nitric oxide
Hydrogen	Carbonic oxide
Sulphuretted hydrogen	Carbonic anhydride.
Nitrous oxide	

#### SECOND OR ADVANCED STAGE EXAMINATION.

Read the general instructions at the head of the Elementary Paper.

You are only permitted to attempt *eight* questions. You may select these from any part of the paper.

The value attached to each question is the same.

You are requested, whenever possible, to express the reactions in equations.

You are to give such numerical details as will show the mode of calculation.

Atomic weights and coefficients to be used:—

Fe=56

Gases expand  $\frac{1}{273}$  of their volume for each degree Centigrade above 0° C.

20. What takes place when carbonic anhydride is passed into:—1st, Distilled water; 2d, Baryta water; and 3d, water containing some freshly precipitated calcic carbonate (carbonate of lime)?

21. If you were required to prepare pure ammonia gas, how would you proceed and what apparatus would you employ?

22. What is an alum? Give the names and formulæ of the different kinds of alum.

23. What are empirical, rational, and constitutional formulæ? Give examples of each.

24. What is the action of a red heat upon the following substances, placed so as to prevent their contact with air:—Fe S<sub>2</sub>—Sn S<sub>2</sub>—Pt S<sub>2</sub>—Au<sub>2</sub>S<sub>3</sub>—As<sub>2</sub>S<sub>3</sub>?

25. State exactly how you would separate from each other and individually detect the following constituents of a solid substance given to you for



F. Frankland,  
Esq., Ph.D.,  
F.R.S.

17 June 1870.

analysis:—Peroxide of mercury, soda, protoxide of iron, oxide of copper, magnesia, sulphuric acid, and hydrochloric acid.

26. Explain the changes which occur when a current of sulphuretted hydrogen is passed through an aqueous solution of each of the following salts:—

Sulphate of copper                      Alum  
Protosulphate of iron                  Corrosive sublimate  
Sugar of lead.

Give equations and draw graphic formulæ of the products.

27. Two volumes of marsh gas, 4 of hydrogen, 1 of nitrogen, and 8 of oxygen, are measured at O C. and 760 m.m. mercurial pressure. They are then mixed together and exploded by the electric spark. What is the volume of the gaseous products at the same temperature and pressure, and what would it be at 200° C. ?
28. How much hydrogen by weight and by volume (in litres) is required to reduce 25 grammes of ferric oxide ( $\text{Fe}_2\text{O}_3$ ) to metallic iron ?
29. You have given to you distilled water, oil of vitriol, nitric acid, copper turnings, iron filings, and metallic lead. State what salts you could prepare from these materials, and describe briefly how you would make them. Give their graphic formulæ and explain the chemical changes by equations.

#### HONOURS EXAMINATION.

##### General Instructions.

In all cases the number of the question must be placed before the answer on the worked paper.

Three hours are allowed.

If the rules are not attended to, the paper will be cancelled.

You are only permitted to attempt *six* questions.

You must attempt the first two questions on the paper. The remaining four you may select from any part of the paper.

The value attached to each question is the same.

Whenever it is possible, reactions are to be expressed in equations.

You are to give such numerical details as will show the mode of calculation.

40. If you were required to make a quantitative analysis of meerschaum, state minutely how you would proceed.
41. How would you perform the qualitative analysis of a substance containing the following ingredients:—Mercurous oxide, stannic acid, arsenious sulphide, tartar emetic, cupric cyanide, ferric phosphate, and baric sulphate ?
42. Upon what optical laws is spectrum analysis founded, and how would you apply this kind of analysis to the discovery of the constituents of the following mixtures ?—No. 1. Hydrogen and nitrogen. No. 2. An alloy of copper, tin, and zinc. No. 3. Barium, sodium, and lithium, as chlorides.
43. The specific heat of lithium is .94, and its atomic weight 7: what are the atomic weights (as deduced from their specific heats) of the following elements ?

	Sp. heat.
A . . . . .	.084
B . . . . .	.054
C . . . . .	.293
D . . . . .	.108

44. Describe the process of manufacturing bleaching-powder, illustrating all the chemical changes by equations, and the constitution of the substances employed and produced by graphic formulæ.
45. What chemical changes, if any, take place under the following circumstances ?—1st. When a mixture of steam and chlorine is passed through a red-hot tube. 2d. When a mixture of oxygen and hydrochloric acid is transmitted through a red-hot tube. 3d. When hydrogen is passed over each of the following substances, heated to redness:—Ferric oxide, stannic oxide, aluminic oxide, manganic oxide, calcic carbonate, and potassic sulphate.
46. I burn hydrogen in oxygen, 1st, at the ordinary atmospheric pressure, and afterwards under a pressure of 5 atmospheres; in which of the two operations will the pyrometric thermal effect be greatest, and why ?

47. You are required to prepare some pure  $\text{Mn Cl}_2$  from the waste manganese liquor of alkali works. This liquor contains  $\text{Mn Cl}_2$ ,  $\text{Fe}_2 \text{Cl}_2$ ,  $\text{As Cl}_2$ ,  $\text{Ca Cl}_2$ , and free  $\text{H Cl}$ ; state exactly how you would perform the necessary operations, explaining all chemical changes by equations.

#### SUBJECT XI.—ORGANIC CHEMISTRY.

Examiner, Professor FRANKLAND, Ph.D., F.R.S.

##### GENERAL INSTRUCTIONS.

You are only permitted to answer questions from the elementary paper or from the advanced paper, but not from both. If the rules are not attended to, the paper will be cancelled.

In all cases the number of the question must be placed before the answer on the worked paper.

Three hours are allowed.

##### FIRST OR ELEMENTARY STAGE EXAMINATION.

You are only permitted to attempt *eight* questions. You may select these from any part of the paper.

The value attached to each question is the same.

Whenever possible, you are to express the reactions in equations.

You are to give such numerical details as will show the mode of calculation.

Atomic weights to be used:—

H = 1  
O = 16  
C = 12

1. Give the formulæ and percentage composition of formic acid and oxalic acid.
2. Give two distinct and different processes for the preparation of ethylene, showing all chemical changes by equations.
3. What is the empirical formula of a substance which yields the following results on analysis ?

Carbon . . . . .	20.00
Hydrogen . . . . .	6.66
Oxygen . . . . .	26.67
Nitrogen . . . . .	46.67

100.00

4. Give the graphic and symbolic formulæ of the following substances:—Prussic acid, acetic acid, alcohol, methyl, and marsh gas.
5. What member of the alcohol family is found amongst the products of the destructive distillation of wood; how can you extract it in a state of purity from wood naphtha, and what is its graphic formula ?
6. How can you detect the presence of nitrogen in an organic substance ?
7. You are required to make 1 oz. of lactic acid from milk; how will you do it ?
8. Give the name and graphic formula of a member of each of the following families of organic compounds:—Alcohols, aldehydes, ethereal salts, ethers and haloid ethers.
9. If a mixture of acetate of potash, caustic soda, and quicklime be heated to a temperature somewhat below redness, what gaseous product is obtained ? Give its name and formula, and state where it is met with in nature.
10. You have given to you the following materials, and are required to make acetic acid; state exactly what operations you will perform, and explain all chemical changes by equations:—  
Ethylic iodide                      Water  
Sodic carbonate                      Potassic chromate  
Quicklime                              Sulphuric acid.
11. If an alkaline solution of potassic cyanide be boiled, what decomposition takes place ?
12. If bitter almonds be macerated in warm water, what member of the aldehyde family is produced, and why is this aldehyde not formed when sweet are substituted for bitter almonds ?

##### SECOND OR ADVANCED STAGE EXAMINATION.

Read the general instructions at the head of the Elementary Paper.

You are only permitted to attempt *eight* questions. You may select these from any part of the paper.

The value attached to each question is the same.

Whenever possible you are to express the reactions in equations.



You are to give such numerical details as will show the mode of calculation.

20. What relations exist between cyanogen and oxalic acid, and how can each be transformed into the other?
21. How can you obtain formic acid from sawdust?
22. If you had given to you some sugar, yeast, water, sodic carbonate and sulphuric acid, and were required to prepare ethylic acetate (acetic ether), how would you do it?
23. If the electric light be produced by the voltaic ignition of carbon in an atmosphere of hydrogen, what chemical change, if any, takes place?
24. Give the graphic formula of a member of each of the following series of organic bodies:—Organic radicals, hydrides of organic radicals; monacid, diacid, and triacid alcohols; monobasic acids of the acrylic, lactic, and pyruvic series; dibasic acids of the succinic and tartaric series.
25. If a mixture of ethylic iodide, ethylic ether, and zinc be heated to 120° C. for some hours in a sealed tube, what changes take place? Give the names, constitutional formulæ, and properties of the bodies formed.
26. How would you prepare glycol?
27. Describe how you would obtain lactic acid and alcohol from their elements, without the aid of animal or vegetable life.
28. What is the weight, in grammes, of one litre of ethyl gas, measured at 0° C. and 760 m.m. pressure?
29. Having the following materials at your command, could you make from them caproic acid, and if so, how?—Amylic alcohol, quicklime, yellow prussiate of potash, sulphuric acid, water, and potassic carbonate.

#### HONOURS EXAMINATION.

##### General Instructions.

In all cases the number of the question must be placed before the answer on the worked paper.

Three hours are allowed.

If the rules are not attended to, the paper will be cancelled.

You are only permitted to attempt *six* questions. You may select these from any part of the paper.

The value attached to each question is the same.

Whenever it is possible, reactions are to be expressed in equations. You are to give such numerical details as will show the mode of calculation.

Gases expand  $\frac{1}{273}$  of their volume for each degree Centigrade above 0° C.

40. How would you quantitatively analyse a gaseous mixture consisting of marsh-gas, methyl, nitrogen, and carbonic oxide?
41. In the endometrical analysis of a hydrocarbon gas, the following numbers were obtained: Fill up the last column of corrected numbers, and give the molecular formula and name of the gas:—

	Observed Volume.	Temp. C.	Difference of mercury level.	Height of barometer.	Corrected vol. of dry gas at 0° C. and 1 metro pressure.
		C.	mm.	mm.	
Gas used (moist)	91.8	12.8°	623.1	752.7	
After admission of oxygen (moist)	535.1	12.9°	160.6	751.	
After combustion (moist)	498.8	12.8°	194.0	751.1	
After absorption of CO <sub>2</sub> (dry)	454.3	13.0°	237.2	741.5	
The tension of aqueous vapour at the above temperatures is—					
At 12° 8	-	11.0	mm. of mercury.		
12° 9	-	11.1	" "		
42. If you had given to you some rice, malt, yeast, water, baryta and sodium, and were required to prepare isopropyl alcohol, how would you do it?					
43. Name the chief constituents of crude coal-gas; state which of them are removed by the process of lime purification, and which by the substitution of ferric hydrate for lime. Mention also the constituents of purified gas to which the luminosity of a gas flame is principally due. Two samples of coal-gas yielded the following results on analysis; to which of them would you give the preference, stating your reasons?—					
				No. 1.	No. 2.
Hydro-carbons other than marsh-gas	-	-	-	10.56	7.48
Marsh-gas	-	-	-	63.51	50.43
Hydrogen	-	-	-	19.41	35.39
Carbonic oxide	-	-	-	5.32	6.70
Carbonic anhydride	-	-	-	1.20	0.00
				100.00	100.00

One volume of the hydro-carbons other than marsh-gas in No. 1 generated 2 vols. of carbonic anhydride on combustion, whilst one volume of these hydro-carbons in No. 2 generated 4 vols. of carbonic anhydride.

44. What do you understand by the terms "normal alcohol," "secondary alcohol," and "tertiary alcohol?" Give the graphic formula of a member of each class.
45. Give the formulæ of the following acids, and mention in each case the hydricity and basicity of the acid:—

Butyric acid	Glyoxylic acid
Leucic acid	Tartaric acid
Pyruvic acid	Citric acid
Malonic acid	Crotonic acid.

46. You have given to you alcohol, iodine, phosphorus, sulphuric acid, ammonia, and potash, and are required to produce a primary, a secondary, and a tertiary monamine; also a diamine. How will you proceed? Give equations.
47. Write out the graphic formulæ of all the possible isomeric modifications of valeric acid.

No. 6, Old Palace Yard, Westminster, Tuesday, 21st June 1870.

#### PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

The Rev. JOSEPH WOOLLEY, LL.D., examined.

836. (*Chairman.*) I believe you are Inspector General of the Royal School of Naval Architecture and Marine Engineering?—I am.

837. Your duties are confined to the general inspection of the school, are they not; or do you take any part in the actual course of instruction?—No, but the

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17 June 1870.

Rev.  
J. Woolley,  
LL.D.  
21 June 1870.



Rev.  
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LL.D.  
21 June 1870.

examinations for the fellowships and associateships are entirely in my hands.

838. You are also an examiner of the Science and Art Department of the Committee of Council on Education, are you not?—Yes, I am.

839. In what branch do you examine?—Navigation and nautical astronomy.

840. Have you had much experience in the examinations under the Science Department?—I have been an examiner seven years, since 1863.

841. What is your opinion as to the results of those examinations; are they doing much good?—I should certainly say that they are doing a great deal of good, judging especially by the last examination. The numbers have diminished very much in the subjects in which I examine, but the character of the work done has greatly improved this year.

842. Then your branch is an exception to the general rule, because in most cases the numbers have been increasing?—Yes, they have been increasing in other branches.

843. Has the diminution in number been owing to any proceedings on your part, or an expression of opinion that many candidates were ill prepared?—I think it is very likely.

844. Do you not exercise considerable strictness in the rejection of candidates?—I think that last year I rejected pretty nearly the whole of the candidates that came up from several schools, which have sent up no candidates this year.

845. Have a considerable number of schools given up teaching those branches of science?—Yes, I think that they have. There used to be some navigation schools in the country, but I think that with the exception of one at Hull and one at Leith they are almost all discontinued now, or at least the others have dwindled down to a very small proportion.

846. Is the decrease in the number of candidates owing to the decrease in the number of schools?—To a very great extent. There was an attempt last year to make boys of nine and ten bring up those subjects which are utterly unsuited to their capacities, and I think that the subtraction of those this year has caused the diminution of the numbers; it is a quite natural and proper diminution, I think.

847. But you consider that the examination on the last occasion was tolerably satisfactory?—Yes, it was satisfactory on the whole, especially in navigation.

848. Did you come to the conclusion that the teachers were pretty well qualified to teach the subjects in which they undertook to give instruction?—In a great majority of cases I should say they were. In fact, the best teachers in the schools that I am concerned with are old pupil teachers of Greenwich. The navigation was extremely well taught in the Greenwich School.

849. (*Mr. Samuelson.*) You spoke of the Navigation School at Hull, that is a day school, is it not?—I believe it is a day school.

850. Do you know anything of that school?—I have never visited it.

851. Do you know whether they send up many papers?—I should think that on the last occasion I had 68 papers only in nautical astronomy, and that quite 40 of them came from the Hull School.

852. Those papers were generally good, were they?—Generally very good; in fact they were the best of all.

853. When you spoke of an attempt to send up papers from boys of nine or 10 years of age, was it from any of the navigation schools like those of Hull or Leith?—No, it was from national schools. I found that they attempted to bring forward boys and make them take up those subjects, and it would naturally be a failure.

854. Have you any knowledge of whether those schools were in seaport towns?—The one that I found out most about was at Dartmouth, and one can hardly call that a seaport town.

855. Still it is a town where seafaring men have their homes?—Very few.

856. How many separate schools did you examine this year, so far as you could judge, from the batches of the papers sent up?—I should think that in navigation, which has a very much larger number than nautical astronomy, there must have been 30 or 40, but in nautical astronomy I should think not above 10 or 12.

857. Do you know anything of the master of the Hull Navigation School?—I know him by reputation.

858. Do you know anything of his antecedents?—He was one of the first pupil teachers of the Greenwich Hospital School, and one of the very best masters of a navigation school in England. I know that his name is Zebedee Scaping.

859. Is it within your knowledge that the pupils of that school are preferred by shipowners as apprentices?—That is quite out of my knowledge. I have no means of knowing that at all.

860. You know Mr. Scaping to be a competent man, and you believe his competency to arise from his having been well trained in the school at Greenwich?—I do.

861. And you attribute the success of the Hull school to the competency of the teacher?—I do quite so, and it is also a well-endowed school, I believe.

862. Do you know anything of the class of boys that attend that school?—I think that they are principally the sons of mariners,—almost entirely so.

863. Would you say that they would rank with artisans?—Rather better, I should think; many of them are the sons of mates, and I should think even of masters, in the mercantile marine.

864. Have any of the old pupils of that school come under your observation at all?—Not at all.

865. (*Dr. Miller.*) Are there examinations held for seamen in the ports at any place?—There are quarterly examinations besides the May examinations, which quarterly examinations are specially designed for those who are at sea.

866. And do many avail themselves of them?—Very few indeed.

867. About how many?—Sometimes as few as 9 or 10 at a time.

868. But I think it is stated that those candidates after the present year will not be admitted, unless there be at least 40 of them?—No; but there never have been for the last two or three years as many as 40 at one time.

869. Is there any pecuniary encouragement given to this branch of study?—The only pecuniary encouragement is that which is given by the payment of the department.

870. There are no special facilities for study; it is merely an examination?—That is all, so far as the department is concerned. In several of the schools there are good teachers. Leith is the principal school that sends up to the quarterly examinations, and there must be a good teacher at Leith.

871. On the whole I understand you to say that the scheme has scarcely answered?—It has not answered; and I think the reason is, that the mariners, and those who are actually engaged in the practice, concern themselves very little except with passing the Board of Trade examination, which is strictly in the art and not in the theory of navigation.

872. What advantage does a man gain by passing such an examination as yours?—None whatever that I know of, except the pleasure of knowing scientifically what he would otherwise only know practically.

873. It would be of no advantage in his profession?—It must give him an advantage in his profession in giving him a better insight into what he is doing.

874. He does not get higher wages, or anything of that kind?—Not at all, unless it might give him a better prospect of getting on in his profession, which I think is very possible.

875. (*Dr. Sharpey.*) Does it further him with respect to the Board of Trade examination?—Not at all, because the Board of Trade examination is simply one in practice, and not at all in theory.



876. (*Chairman.*) Now will you refer to the school in naval architecture; have you held your present position since the original establishment of the school?—I have.

877. Can you give the Commission any information as to the circumstances under which this school originated, and which led to its establishment?—It originated from a feeling which existed, especially amongst some of the leading members of the Institution of Naval Architects, that the professional knowledge of naval architecture in England was very slight indeed; simply in fact experimental, not at all theoretical; and the Admiralty themselves having no longer any school of naval architecture, wanted persons better trained than they could otherwise be in the theoretical knowledge of those subjects.

878. Was it represented to the Government that there was a requirement which could not be met from any private institutions?—It was so.

879. The course of instruction extends over several years, I believe?—Now over four years; it was originally three years.

880. Were three years found insufficient?—Three years with the extreme number of subjects that they have to acquire were found insufficient for the purpose. The course at South Kensington consists of only seven months in the year, and there are five months of practice in the dockyard; and they have to attend, while they are at South Kensington, not only to the theory, but to a great deal of the practice also.

881. Is there any limit of age at which pupils are received?—None at all that I am aware of.

882. What is the most common age?—Practically I can speak best of the Admiralty students; and they would be about 19 or 20.

883. There are two classes of pupils, are there not?—There is one class sent entirely by the Admiralty for their own purposes, and there are private students also.

884. How are those students selected by the Admiralty?—By examination from the dockyard schools. I examine them and select them in conjunction with the Chief Constructor of the Navy. He takes the professional subjects, and I take the purely educational subjects.

885. Are there schools at all the principal dockyards?—There are schools at all the dockyards.

886. But there are no schools conducted specially with a view to navigation or to naval architecture?—The apprentices many years ago were found to be very ignorant, and those schools were intended to give them, in the first instance, the elements of some ordinary knowledge, and since that it has been found in the course of four or five years that some of them are able to acquire a considerable amount of mathematical training, and a training in chemistry and physics of an elementary kind.

887. Are 30 of the best pupils of those schools annually selected?—Not 30 annually, but 30 spread over four years, and they vary from six to 10 every year; so that the whole number should be made up to 30 for the whole four years.

888. Are they maintained at the Royal School of Naval Architecture at the public expense?—Yes, entirely at the public expense.

889. What is the other class of students?—Those, I suppose, who wish ultimately to obtain employment as naval architects or as marine engineers, and who think that they would better their prospects by getting their theoretical knowledge at the school.

890. Are all received that offer themselves?—That has been almost practically the case; but there is supposed to be a preliminary examination in elementary mathematics, and that is enforced now in fact.

891. Would none of those who are unable to pass that examination be admitted?—No.

892. Some of the earlier pupils of that school have now completed their education, have they not?—Yes.

893. Have you any means of tracing what has

become of them since they left the school?—I know what has become of all the Admiralty students.

894. Are they now employed in the public service?—All of them, except one; and I think he is employed in Lloyds.

895. What has been the result; has it been satisfactory?—I think quite so. There are two of them at this moment employed in the constructor's department, and there are two upon whom they can depend better than upon any others, except the constructors themselves.

896. Do you think that they will furnish a class of servants for the public service superior to what could otherwise have been obtained?—A very great deal superior,—such a class as could not be obtained otherwise. A great many of the others are out inspecting the building of ships under private builders.

897. Are those the private students?—No, Admiralty students; and they are employed in confidential work on behalf of the Admiralty.

898. Are they in receipt of considerable salaries?—Something like 150*l.* a year, or even more, some of them in London. I can hardly say exactly.

899. With a prospect of being able to rise to offices of greater importance?—The best of them will ultimately rise to offices of 600*l.* or 700*l.* a year in the dockyards, and become constructors themselves.

900. Was the number of students for whom the school was intended originally to provide greater than are at present admitted?—No; I do not think there was ever anything definitely reckoned as to the exact number of private students. Thirty Admiralty students are always reckoned upon, and not more.

901. Then the school is doing as extensive an amount of work as it was expected?—Some people may have expected more, but I never did. I do not think that the time has come yet that the private shipbuilders would value that kind of instruction sufficiently. There is not a very great demand in the country generally for scientific instruction. People are generally satisfied with mere professional instruction of an inferior kind. I do not think there is much demand amongst the private employers for much more than that at present.

902. What is the staff of the school?—The staff consists of a principal and a vice-principal, and then there are several teachers. There is one teacher of drawing of naval architecture, another teacher of marine engine drawing, and then there are two who give occasional assistance in naval architecture and design, and in marine engine design. Those are the permanent staff of the school.

903. And what is the annual cost of the school?—As far as I can make out it is about 2,700*l.* a year, and that includes a very considerable sum that is paid for lectures, about 500*l.* a year. I am not of course including in that what the Admiralty pay for the students for board and lodging. That I do not think is properly a sum that would be included in the expenses of the school of naval architecture.

904. On what ground do you consider that not to be part of the expense of the school?—Because they must be provided somewhere, and that is a private arrangement of the Admiralty entirely, and not with the school at all. The only arrangement between the school and the Admiralty is that the Admiralty give the school 25*l.* a year for each pupil that they send for instruction.

905. Besides the work of the school itself during the summer the pupils are at work in the Royal dockyard?—Yes.

906. Under whose superintendence are they at that time?—Under the superintendence of the principal dockyard authorities.

907. Do you lose sight of them altogether?—No, I do not; they all are required by the Chief Constructor of the Navy to write monthly journals which are sent up to London, and I have an opportunity of seeing and inspecting them.

908. Has the principal of the school anything to do with them during that period?—Nothing whatever.

*Rev.  
J. Woolley,  
LL.D.*

21 June 1870.



Res.  
J. Woolley,  
LL.D.  
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21 June 1870.

909. Are they dispersed in certain proportions amongst the different dockyards?—Yes, they are according to the work that is going on. They are generally sent so that they may have an opportunity of inspecting the best kinds of work in different positions.

910. Do you think it important for them to go through such a course of instruction?—Very important indeed. I may also mention that the Admiralty are good enough to allow private students to attend the dockyards in the same way, and on the same conditions. They are allowed to select their own dockyard, and they go to them on the condition of complying with the ordinary rules.

911. (*Mr. Samuelson.*) There was formerly a school of mathematics and naval construction at Portsmouth, was there not?—There was.

912. Were you connected with that school?—I was the principal of it.

913. How long did it exist?—Five years.

914. And it was closed in 1853, was it not?—It was.

915. What was the success of that school?—The chief constructor and the three constructors of the navy at this present moment were pupils of that school, and all the others are occupying high positions in the different dockyards of those that remain in the service, and some are dead; but I should think that three-fourths of them are what are called foremen in the yards—or assistant-master shipwrights.

916. Why was that school given up?—I think it was given up because it was said that they did not want so many trained persons, and could do without them.

917. By whom was that alleged?—I have always believed, and I think I have reason to believe, that the Department of the Surveyor of the Navy was not friendly to the school from the beginning; and certain promises were made to the students which when the time came were broken, in consequence of its being said that it was impossible to provide for them. They were all in fact to be made leading men, but when the time came to appoint them leading men there were no places where leading men were required.

918. Then the school was established at the suggestion of persons holding political positions, and was not favoured by the permanent officials?—Quite so; that is to say, the permanent officials in the ship-building branch.

919. What is the state of things with respect to the present school; is there some difference of opinion between the executive department and the superior officers?—At this present moment there is the best of understanding with everybody in the Admiralty. They favour the school, and do everything they can to give suitable positions to those who pass through it.

920. The permanent officials are equally anxious with the political officers now to promote the interests of the school?—Quite so. In fact the permanent officers, those having the greatest weight, are those who were formerly educated at the school of mathematics and naval construction; and they naturally, I suppose, knowing the value of the education, favour the present system.

921. And have you sent out a sufficient number of pupils from the present school to test the value of the school?—I think so.

922. Which is fully acknowledged by those under whom they are employed?—Quite so. In fact I may say that the first we sent out is employed a great deal confidentially under the Chief Constructor of the Navy, who finds him, I know, a very valuable subordinate.

923. In answer to a question of his Grace the Chairman you drew a distinction between naval architects and marine engineers. Is not that a difference which is every day diminishing?—As regards the dockyards it is; but there is an essential difference as regards the students, because one half of the Admiralty students are from that class who have been brought up at the dockyards and in the factories with the

design of becoming engineers on board ship, and they are not intended to be removed from that profession; 15 out of the 30 that are at South Kensington will become engineers in the navy. That will be their profession, and it is not intended to take them away from it.

924. But the naval architects must necessarily also be acquainted with marine engineering, must they not?—They are to a great extent.

925. Are there any other means in the country at present of acquiring theoretical instruction in the profession of naval architecture and marine engineering?—I know of none, unless it may be that Professor Rankine, of Glasgow, has a class; but whether in his class he comprehends much of naval architecture I do not know, but certainly nothing so systematical or in the same way as it is with us; but I know of no other place where the knowledge is professed to be given.

926. Have you any means of judging whether the application of theoretical knowledge to the art of naval architecture has led to very striking results?—I can only instance the present Chief Constructor of the Navy, who I presume obtained a great deal of theoretical knowledge at the School of Naval Architecture at Portsmouth between 1848 and 1853.

927. Without which theoretical knowledge you think that he would have been much less successful?—I do not think in the first instance that he would have been likely to have turned his attention to that branch of knowledge at all.

928. But your experience is that the advantages of the school are not generally appreciated by naval architects and marine engineers in private practice?—I think not.

929. Do you know in what way those men are educated?—The chief builders and heads of the firms themselves, I suppose, have the education of any other gentleman in the country, especially in a mercantile point of view. It is a mercantile education they receive more than anything else. They generally have draughtsmen and other people who design their ships, who become in some way or other acquainted with the principal types of vessels and engines, and who have a practical acquaintance with them, but nothing beyond that.

930. Of course you will admit that in spite of the want of theoretical instruction those men are very competent engineers?—Certainly.

931. But you would consider that they would be likely to be much more competent if they were theoretically instructed, as well as having the large amount of practice which they possess?—I should think so.

932. You have no doubt at all about it?—None whatever in my own mind.

933. It is the case, is it not, that in foreign countries the amount of practical knowledge possessed by naval architects and marine engineers has increased very much lately?—Very much indeed.

934. So as to place them much more nearly on a level with us in that respect, and their theoretical knowledge is likely to be much greater than that of men trained as our naval architects and marine engineers in private practice are trained?—Quite so.

935. Have you given any attention at all to the question of enlarging the sphere of the School of Naval Architecture so as to embrace persons wishing to devote themselves to engineering generally?—Yes, to some extent.

936. Will you kindly give the Commission your opinion upon that subject?—My opinion is, that much of what is now taught at the School of Naval Architecture would be common to some other professions. In fact it would be done better if in a school of application, as the School of Naval Architecture is, we had a system similar to what they have in France of a Polytechnique school followed by schools of application, that would be a much better system than you could possibly get by attempting to combine in one school mathematical knowledge and application together. What we suffer from in this country is from our not having a general



school in which people destined for public departments are all educated together up to a certain standard as far as can be, and then afterwards sent out into schools of application for the special branches. That is the best system in my opinion.

937. Would you regard that school as being capable of becoming the general school of which you have spoken?—It might become the nucleus, and then it would branch off into two. A great deal, for instance, of the mathematics which is taught might be made available for persons who are wanting to study for many other professions, engineers generally, or architects. A great part of pure mathematics, for instance, is not special to naval architecture; it is only necessary in order that people may have a competent knowledge in subsequent applications.

938. You say that it would branch off into two departments?—I think it would do so.

939. The second department would then be simply that of naval architecture and marine engineering?—Quite so, in its higher departments. Then the present four years' course would perhaps be two years at the general course, and two years in the school of application.

940. Have you any classes which are duplicates or nearly so of other classes conducted in Government institutions or establishments?—I do not think that there is much done in most of the Government establishments: all that I know of is in such establishments as Woolwich and Sandhurst, but I should think that even for them the engineer or artillery officers must be educated up to a certain extent in the general school and then afterwards be a shorter time in the special school for engineering or artillery. At Woolwich they attempt to do what we are attempting to do, and at South Kensington we give them what would be given in France, partly in the polytechnique school and partly in a school of application of artillery or engineering.

941. Then that general school with respect to officers in the army and navy would hold the place of the *École Polytechnique* and the subsequent teaching would be in their own special local schools?—What I would say is, that if you established a school something like the *Polytechnique* school in France our students would go for a part of the time there, and then afterwards go to their special school of naval architecture. What we do now is to attempt to combine the two, because we cannot get the instruction in any other manner.

942. Have you any classes parallel to those of the School of Mines?—No, I think not; unless you call the School of Mines in its department similar to that of naval architecture and marine engineering.

943. I mean the School of Mines which exists in Jermyn Street?—No, I do not think we have anything exactly common. I think it would be a very great advantage if the School of Mines were brought more into communication with our school; for we have the greatest difficulty at present in getting good instruction, except at enormous cost, and a great waste of time in many departments, such as chemistry and physics. We feel the want of some school like the School of Mines in immediate contact with us very greatly indeed. We have the greatest difficulty, which we have only just overcome, in getting anything like sufficiently good elementary instruction in chemistry for instance. We have just come to an arrangement with Dr. Frankland only within the last two or three days, so that we may be able to get 20 good lectures in the course of the year for our students.

944. Which lectures will be delivered at South Kensington?—We have arranged that they should not; we are to let them go to the College of Chemistry in Oxford Street.

945. Then so far the two schools will be amalgamated?—Yes; but it would be much more satisfactory and much more serviceable to us if we had the college of chemistry under the same roof with ourselves. There would be all that waste of time going backwards and forwards saved.

946. Are there not some very extensive laboratories in course of construction at South Kensington?—There are in connexion with the future building for the School of Naval Architecture; but they have been in abeyance for two years.

947. But some progress is now being made again, is there not, with those buildings?—Yes, there is.

948. And those laboratories were intended primarily for the School of Naval Architecture?—I think they were designed for the School of Chemistry, and the School of Naval Architecture was to have its share in them; they were not entirely for the School of Naval Architecture. I think it was intended to remove the College of Chemistry to South Kensington.

949. Have you heard any plan suggested of establishing a school for training science teachers?—I have heard of no such system.

950. Assuming such a school to be established, would there be many subjects which could be taught by the same professors and in the same manner to those science teachers and to the pupils of your school?—Yes, a great many subjects certainly; all in pure mathematics, for instance, or at least the greater part.

951. And in physical science also?—Yes, in physical science also.

952. So far as you pretend to be a general school, or what you call a polytechnic school, the instruction in your school is very similar, is it not, to that which the science teachers would require?—Yes, the higher class of science teachers decidedly.

953. Are the students of your school employed in actual construction during the period which they spend in the dockyards?—They are, with the addition that they are obliged to keep a journal, and to make sketches of the most interesting work in which they take a part, and which they otherwise see.

954. You are aware, are you not, that one of the defects which is acknowledged to adhere to the system pursued in the continental scientific instruction is that there are but few opportunities for acquiring practical skill on the part of the pupils?—At the French School of Application du Génie Maritime, which corresponds with our School of Naval Architecture, their pupils are employed in the summer months in the dockyards, and I think they would have similar opportunities to our own. The difference would be this, that when they first go many of them would not know the stem from the stern of a ship, or the inside from the outside of an engine, they having never seen them, having merely had theoretical instruction at the *École Polytechnique*; whereas all our students who come from the dockyards have been actually employed either on marine engines or on shipbuilding for four or five years, and have got a great deal of practical knowledge.

955. And that combination of science and practice you consider to be the best course which a man can follow?—I do. I think that the French system is defective. I think it is too late to take up a study like that of a practical knowledge of naval architecture so late in life as is the case with a pupil leaving the polytechnic school, to say nothing of the fact that no person then would take to work and do it similar to a workman, and therefore he would not acquire the practical knowledge which is very desirable in a person who is going to superintend such establishments afterwards, whereas all our students have been actually working and earning their wages for four or five years.

956. According to the continental system they do not learn the practical use of tools till they are 20 or 21 years of age?—I very much question the fact whether they ever effectively learn the use of tools at all, commencing, as they do, so late in life.

957. Do you know anything of the *École des Arts et Métiers* in France?—No.

958. (*Dr. Sharpey.*) I think you make a clear distinction between instruction in pure science and in its practical applications?—Quite so.

959. Do you think that in the school with which

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LL.D.  
21 June 1870.



Rev.  
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21 June 1870.

you are particularly connected the first two years that are now employed in that school might be devoted to the acquisition of pure science?—Yes, I think it would be a very good division.

960. And then to study the applications afterwards?—Yes, I think so.

961. What is your view as to the source where the pupils might get that instruction in pure science; might it be in any of the Government establishments, or might it not be in independent establishments, such as the universities, and others now existing in the country?—I think what we should require could only be got in a special school which would be best under the sanction of the Government, something like the Polytechnique school in France.

962. But still the subjects that would be taught there are in common with those that are taught elsewhere, are they not?—To some extent; but then the universities, from the very nature of the case, go much further in the way of theoretical knowledge than we should care to do, or than it would be desirable to do; therefore that would be so far a waste of time.

963. No doubt that is the aim of some of our universities, but take the case of Owen's College, Manchester, or King's College, or University College, London, where instruction is given in mathematics, and in chemistry, and in physics, might not the knowledge required be obtained in one of those institutions, or in institutions like them?—I think it might be certainly; but I think that the Admiralty would hardly like to send their students to a private establishment, where they would have no control over them.

964. You think the chief reason then for sending them to a public establishment is that they would be looked after?—They would be looked after, and everything in the way of instruction would be given just in proportion to their needs.

965. Apart from the question of looking after the conduct and mode of life of the students, and with reference solely to the instruction obtained; could not the amount of that instruction be tested by examination?—It might be so.

966. Might it not be stated in a programme what was really required, and the acquirement tested by examination?—It might be. Then it is a question whether those establishments, such as King's College, which look to other objects for their students, would care to go into a more special groove for a particular and a very narrow class of students. I think it is a very doubtful question.

967. Has King's College now any class of applied science?—They have, but that is chiefly for civil engineers, I think.

968. Could not the extent of mathematical study deemed requisite be determined by a programme?—Yes, I think it might be done, certainly.

969. Then with regard to the competency of the teaching; to avoid invidious selection, I may refer to men who are no longer teachers, such as Professor de Morgan or Mr. Hirst; it would make no difference to them whether they taught in an independent school or in a Government school?—No, I should think not.

970. Or the late Mr. Graham, formerly Professor of Chemistry?—Certainly not.

971. Which would be the most economical, do you think, with regard to the outlay of public money?—That I am hardly prepared to answer, but I should think it would be very much the same as it is now.

972. I see that one of your students for four years' instruction costs about 350*l.*?—Yes, that is about the amount; I suppose about 65*l.* or 67*l.* a year would be the price of each.

973. Are you aware that a medical student in any of the schools in London obtains four years' instruction in a variety of subjects for less than 100*l.*?—Yes, I suppose it is so.

974. And that includes hospital practice, which in fact might be set off against what is given gratuitously, in the case of your students, at the dockyards?—I

think you must put in opposition to that the fact that the teachers do not give their whole time to instruction. The teachers in those medical schools are physicians and surgeons in considerable practice, and only give a portion of their time to teach, whereas in the other schools their whole time is given to instruction.

975. I am not speaking of the remuneration of the teachers but of the expense of the education; it is admitted that our medical schools may require revision and improvement, and it is to be hoped that they will be amended in various respects, but still at present the country is supplied with competent medical men at that rate?—I think it could not be done so if medical schools were taught only by persons whose whole professional income was derived from the fees of the students, which is not now the case.

976. The question is whether if the students of naval architecture and marine engineering received the previous training in independent institutions, it might not be more economical than establishing a Government school for that purpose?—The object of my remark was to show that medical schools from the very nature of the case are exceptions, and are not to be compared with the ordinary schools of education, because the teachers in them are physicians and surgeons in considerable private practice, and it serves their purpose to give part of their time for the instruction of students; therefore, I do not think you can make a comparison.

977. (*Professor Huxley.*) I think it seems to be your view that the general and scientific instruction with which persons should be prepared before coming up to the School of Naval Architecture should also have had so to speak a certain special direction?—I think it is desirable that it should be so.

978. And I gathered from what you said about the existing colleges, that in your judgment the scientific instruction which is given in them is limited and determined to a great extent by the character of the students who already attend those colleges; that is to say, that some of those students are going up for degrees in arts, and some are going up for degrees in medicine, and consequently the instruction given at those colleges, even in general science, is to a great extent determined by the necessities of the students, and therefore cannot be precisely fitted for the purposes of your naval school?—That is what I intended to convey, and I doubted whether it would be worth the while of those institutions to narrow their course, or to introduce a special course with the object of serving a special and small class.

979. (*Dr. Miller.*) I observe that you state that there is 500*l.* a year allowed for lectures; what does that mean?—There are lectures on professional subjects to a very great extent; there are lectures on the theory of construction of naval architecture. The Chief Constructor of the Navy has been good enough generally speaking to give 10 lectures upon shipbuilding and kindred subjects; and we are also obliged in that way to get what little instruction we can get at present in physics, which I am sorry to say is not nearly so extensive as I could wish in consequence of our severance from the other establishments.

980. With regard to chemistry an arrangement has been made, has there not, with the Royal College of Chemistry?—There has.

981. And that I suppose is a gratuitous arrangement so far as the School of Mines is concerned?—No, we have to give 150*l.* a year for the instruction that is to be given to us in that way.

982. But is it a special course that is given to your students?—Yes, a special course which is given entirely to our students. Dr. Frankland would have been very glad for our students to have attended his general course, but it was simply impossible on account of the time; it would have destroyed the whole of our course, or interfered with it so much that it could not possibly have gone on satisfactorily; therefore he provides a special course at such a time as we can spare the students.

983. I notice that you state that several of those pupils



have been earning wages themselves; how is it that at the time that they were pupils of the school it would be necessary for the Admiralty to maintain them?—They are apprentices or engineer students bound to the Admiralty for a certain number of years.

984. Then they receive wages, and in addition the Admiralty maintain them whilst they are paying them wages?—Yes, quite so. I think it is a guinea a week that they are allowed while they are away from the yard, in addition to their wages.

985. About what is their wages?—In the case of shipwright apprentices it varies from 6s. 6d. up to 12s. a week, according to the length of service; the engineer students have double that.

986. Do you require any knowledge of mathematics on the part of the students who come up?—Yes, a very considerable knowledge of mathematics.

987. You formerly had a school at Portsmouth for the same purpose, had you not?—Yes.

988. Do you consider that the circumstances at Portsmouth were favourable for the maintenance of such a school?—No, I do not think that they were. It entirely broke down in the practical part of the instruction. They were put under the master shipwright, who had no time to attend to them, and there was a very inferior officer in immediate charge under him who was afraid to make representations, and as a matter of fact they got very few opportunities of good practical knowledge.

989. My object in asking you the question was to ascertain whether in your judgment it was better that the school should be in the immediate vicinity of a naval yard, or whether it was better that the school should be in London?—I think it is better away from any special yard, because there is a difficulty in detaching it then from the immediate superintendence of the person who happens to be the master shipwright. I think it is very often not a very good thing to leave the entire control of the practical part in his hands: whereas as it is now it is superintended immediately from Whitehall, and by this system of journals it is impossible for them to be neglected.

990. Have you daily reports as to what the students are doing?—Monthly reports. They send up a journal containing sketches of what they do, and that being sent to the Chief Constructor, by whom it is carefully looked over, it is impossible that they can be neglected at the yard; whereas I know in former cases they were very much neglected at Portsmouth.

991. How many students are now in attendance at the School of Naval Architecture?—40 is the total number; 30 Admiralty students, and 10 private students.

992. And is that school open to any person; that is to say, does everybody go through the ordinary matriculation, or may any person come?—Any person may come on paying the fee, if he can satisfy the principal, whose business is to look to that, that he has sufficient mathematical knowledge to benefit by the instruction given.

993. Are any pupils sent to the school from foreign governments?—Yes, there have been four students from Russia; and at the present moment there are three students from the Egyptian government; and there is one Dutchman from a private firm in Holland, but he is not sent by the government.

994. The laboratory of the school is a very extensive one, is it not?—The present laboratory is not at all an extensive one; but it will be so.

995. Do you know what is the estimated expense of its construction?—I do not. Dr. Hofmann gave an estimate of it.

996. Was it 40,000*l.* or 50,000*l.*?—It was some considerable sum, but I cannot charge my memory with it.

997. Was it not enough to buy the whole of the laboratories in England?—I do not know what the exact amount was, and I cannot give any opinion.

998. (*Marquis of Lansdowne.*) Have you told us the usual age at which the Admiralty pupils and ordinary pupils come to the School of Naval Architecture?

—The Admiralty pupils are from about 19 or 20. The ordinary pupils vary; some of them come as young as 17 or 18; and a few who come for special purposes of their own, and go through only a part of the course, may come as late as 30 or 40. I think there is one at present who is something like 40.

999. If this division, which I think I understood you somewhat recommended, of the whole course into a theoretical course and an applied course were to be adopted, the Admiralty pupils, who come I think you said from 19 to 20, might come later, might they not, and might complete the first half of their course were it possible to do so elsewhere?—They might do so.

1000. That would be a considerable saving of expense, I presume, because the present course is an expensive one as compared with other courses?—Yes, it would be a saving of expense.

1001. With regard to other ordinary pupils, are they obliged to complete the whole course?—They go through the whole course; but there are very few of them who come well enough prepared to do very well, and to obtain a great deal of mathematical knowledge there.

1002. How does the course end?—There is an examination at the end of every session; and those at the end of the fourth year compete for the degree which is given, of being fellows or associates.

1003. Very few of them attain, I presume, to that degree?—Very few private students.

1004. Have you any means of ascertaining the future career of private students?—I have heard of one or two, and I think I have heard of several of them being engaged in private business. One of the former private students is at present the assistant secretary of the Institution of Naval Architects.

1005. (*Chairman.*) I think you stated that there are several branches of physics in which, if possible, it would be desirable that your students should be instructed. What are those branches in which you think that your course of instruction is defective?—I should like to have a more extensive course, if possible, in magnetism and electricity, and subjects of that kind, which we really have very little means of getting. We get a course of about six or seven lectures only in the year on those subjects, but they are not enough for the purpose; and we could have more if we were in connexion with some more extensive establishment.

1006. In your opinion ought the instruction in those branches of science to be of a special character?—No, except as regards magnetism, which ought to have a special connexion with the correction of compasses. We have had the advantage this year of having three lectures by the present astronomer Royal upon magnetism, especially with reference to the correction of ships' compasses, and a very valuable and interesting course it is.

1007. At the present time you have made arrangements for short courses of lectures?—Yes, we have to the extent of about 500*l.* a year.

1008. You stated, did you not, that you think the first two years of the course might be rendered useful to a more extended class of students?—I think it might.

1009. What are the employments or professions in which you think students might be satisfactorily educated at your institution?—I think engineers generally and architects, I am hardly prepared to say exactly the professions, but all those to whom a considerable knowledge of mathematics would be valuable.

1010. You would not propose, as I understand, to establish any additions to the present course, and you would allow a certain number to leave at the end of the first two years?—Yes, if you take our present machinery, but I would rather have a special school corresponding to the Polytechnique school, and then go on to a school of application afterwards.

1011. (*Dr. Sharpey.*) Do the Admiralty students reside in any public institution?—No, they do not;

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21 June 1870.



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21 June 1870.

they are allowed to reside in lodgings. There is a certain amount of supervision kept over them.

1012. What sort of supervision is there?—It is not anything very great. The places where they live are known, and if anything went wrong it would be inquired into, but I am very glad to say that we have had no complaint of any kind: our students have conducted themselves extremely well. Perhaps I ought to say that in the dockyard schools the ordinary apprentices enter with a very small amount of knowledge indeed, but in addition to mathematics I have made a very great point of their being instructed in elementary chemistry and physics; I consider that a matter of very great importance before they come to Kensington. There is usually given once every week a lecture of an hour or an hour and a half, illustrated by apparatus in chemistry and natural philosophy generally, and the examiner in chemistry has pointed out to me that the earlier students at the school at South Kensington show more knowledge of chemistry than those who have been there a year or two after.

1013. (*Chairman.*) Are the dockyard schools open to the public generally?—They are entirely for the apprentices and engineer students.

1014. Are the apprentices selected from amongst the children of persons altogether employed in the dockyard?—Not necessarily at all. There is a certain list which is kept by the superintendent of the dockyard; and then there is a competitive examination which is conducted by the Civil Service Commissioners, and the Admiralty take their recommendation of the best, and the same course is pursued with regard to engineer students.

1015. At what age do they commence at the dockyard schools?—14 years of age.

1016. Then they must have received some pre-

liminary education?—The dockyard apprenticeships are not in great request, and therefore it has been found, lately more especially, I believe, impossible to insist upon any very high standard of education on admission; in fact they come now with very great difficulty, and it is very up-hill work to teach them. But it is very different with the engineer students, because they are in great request, and we get very well-instructed and clever boys to enter as engineer students.

1017. (*Mr. Samuelson.*) Are those schools at the dockyards night schools or day schools?—They are allowed to miss work in the yard for two half days every week. Every person in the dockyard school attends the afternoon and evening of two days in the week and the evening of a third day. The Government cannot afford to give them up more time than that from their work.

1018. How would you compare the degree of instruction in science given in those schools with the instruction given in the elementary science schools in connexion with the Science and Art Department?—I do not think that any of them would pass well in any one separate subject; but we attempt to give them a little elementary knowledge in several subjects. They get a knowledge in chemistry of the principal gases, and some knowledge of some of the metals and of some chemical combinations; but they cannot go very far in that, because it would take too much time.

1019. (*Dr. Sharpey.*) They would not pass high?—No, they would not pass high; not like those who give themselves up entirely to one subject.

1020. (*Chairman.*) Are there any other points upon which you could add to the information which you have already given to the Commission?—No; nothing occurs to me at present.

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C. W. MERRIFIELD, Esq., F.R.S., examined.

1021. (*Chairman.*) I believe you are the principal of the Royal School of Naval Architecture at South Kensington?—I am.

1022. You also hold another appointment at Kensington, do you not?—Yes; I am superintendent of the Naval Museum there.

1023. Have you been principal of the School of Naval Architecture since its original establishment?—Yes, from the beginning.

1024. That school has been established about six years, I believe?—Yes.

1025. Were any schools of the same kind existing in the country at the time?—No, no other school of the same kind.

1026. Previous to the establishment of the Royal School of Naval Architecture, had not there been other schools with similar objects in view?—Yes, two in succession, at different dates, with an interval between them.

1027. What were those schools?—I cannot give the exact names of them, they were both Admiralty Schools established in the dockyards. The first school existed for three or four years and was broken up, I think, about 40 years ago, and the second school was the one under Dr. Woolley at Portsmouth dockyard. This I think began in 1849, and lasted three or four years, but I could not give the exact dates.

1028. Are you aware of the circumstances in which the establishment of the present school of naval architecture originated?—It was felt both at the Admiralty and by Dr. Woolley that some special instruction was needed for first-class foremen, especially to take charge of the new work that was likely to arise out of iron shipbuilding, and at the same time Mr. Scott Russell, and a good many influential persons, working at the institution of Naval architects, co-operated in bringing it about, but upon that point I think you will find it much more easy to obtain accurate information from Dr. Woolley than from myself.

1029. Are there not a certain number of pupils

sent to your school by the Admiralty?—They send up 30, distributed in four years.

1030. Have you also a number of private students?—Yes, they have fluctuated from two at the beginning to, I think, 17 at one time, and have now fallen off to 10.

1031. Then the whole number of students in the school does not exceed about 40, distributed over four years?—Precisely so.

1032. Are there only ten in each year's course?—No; they are not accurately divided in that way; there may be seven or eight in one year and 12 or more in another.

1033. Are the private students generally persons of much the same qualifications as those sent up by the Admiralty?—As a general rule not nearly so good.

1034. The Admiralty pupils are persons of superior abilities or attainments?—Yes, persons of superior ability and education.

1035. What are your regulations with respect to scholarships and free studentships?—We grant, on examination, if there are a sufficient number of candidates, two scholarships of 50*l.* a year annually, and to two others we grant free studentships, but in general these have not all been given away because there has not been a sufficient number of qualified candidates.

1036. How long are the scholarships tenable?—For the whole course of four years.

1037. Do they receive those scholarships when they first enter?—Yes.

1038. What are your regulations with respect to examinations, are they annual or more frequently?—The official examination is held annually. I also hold myself at the beginning of each session an admission examination to ascertain whether the men are reasonably fit to go through the course, but that is not compulsory, except for those who compete for scholarships, and an examination is held at the end of every session by Dr. Woolley.



1039. Is the annual official examination conducted by gentlemen holding office in the school?—Not working in the school, but by the Inspector-General, who is only connected with the school as examiner, but who also had the right of looking in to see how the discipline and instruction are going on intermediately.

1040. Is he the only examiner?—Except such examiners as he calls into assist him.

1041. The total cost for each student for the whole course I understand is about 700*l*.?—I must correct that figure. The total cost of tuition is much less than that. But I should also reduce this figure as it stands to 600*l*., including the whole cost of board and lodging and maintenance, and it would be much the same thing for private students living economically. In strictness a large portion of that does not concern us, because it includes the wages paid by the Admiralty, and the allowance of a guinea a week paid by the Admiralty to find their students in lodgings and board in London, and even so it is only about 600*l*. for the course instead of 700*l*.

1042. Are you of opinion that the course of instruction at the school embraces all branches of knowledge in which it is desirable that the students should be instructed?—At least that. My impression is that if the course has any fault it is somewhat too ambitious.

1043. You would not like to see any additions made to it or the substitution of any other branches of knowledge?—I think not, if every branch taught in the school were made compulsory on every student.

1044. I think we understand you that, in addition to the regular staff, courses of lectures are occasionally delivered to the students by persons not immediately connected with the school?—That has been an important feature in the school. It was hoped that we should get a considerable attendance of the public at those lectures; but it has been very small.

1045. Do you think that those courses of lectures are an important addition to the regular course of instruction at the school?—In some branches I think it would be difficult to supplement them, but I have great doubts whether their utility is quite commensurate with their cost.

1046. Are there no examinations of pupils after those courses of lectures upon the subjects to which they relate?—No; the examination, if any, is final at the end of the year.

1047. And does that examination include those branches of knowledge in which the courses of lectures have been delivered?—Yes.

1048. Such as chemistry?—In chemistry we have more than that, we have a laboratory attached to the school.

1049. Besides the instruction at the school, are the pupils employed in the dockyards during the summer?—They are.

1050. You, I understand, have no control over them during that period?—I have no control over them during that period. Of course I know nearly what they do.

1051. What regulations are made to ensure their being fully employed during that time?—They are made to keep an accurate diary; that diary is sent up to the controller's office and carefully looked over by the Constructor of the Navy, or by some subordinate officer; and I hear from students that they frequently get remarks about mistakes or omissions or careless work appearing in what they have done.

1052. Do you think that is a valuable portion of the course of instruction?—Very valuable indeed, especially if the diaries are looked over in that manner.

1053. Do you find that the students after returning from their summer course have acquired in the interval information which renders their course of instruction easier or more advantageous subsequently?—They have evidently supplemented it by practical work; but I do not know that that bears very directly upon the theoretical instruction which I have to give them.

1054. Do the private students come up deficient in primary education?—Generally they do.

1055. Is there a marked difference between them and students from the Admiralty?—Very great indeed; the Admiralty students have generally got a very practical knowledge of what they profess to do; whereas the private students very often come to me professing to have learnt algebra or geometry or even some higher subjects than that, but without any real knowledge of those subjects.

1056. To what class do the private students usually belong?—I think I have had them from nearly every class of those that could afford to pay, including the sons of mechanical engineers and of shipbuilders. I have even had clergymen's and barrister's sons, and of various people from various trades and professions.

1057. All with a view to become naval architects subsequently?—I think so—naval architects or marine engineers.

1058. Have you any means of tracing what becomes of them subsequently?—A few of them.

1059. And also the Admiralty students?—The Admiralty students of course I keep more or less in sight, but I could only speak of them from hearsay. I hear a good account of them as a class.

1060. Have you also a certain number of foreign students?—I have had foreign students. I have had four Russian students sent over by the Russian Government. I have had a Dutch private student. I had an officer of the Norwegian navy who came over for one session, and I had five Egyptian students sent over to me, of whom I only retained three during the session, finding the two others not sufficiently informed.

1061. Are the fees required from them sufficient to cover all the cost of their education?—No; the fee is only 25*l*. a year, with the power of getting a small reduction on that by compounding, but I should think that the cost of tuition, dividing the estimate by the number of students, comes to about 67*l*. roughly, per student. They pay a fee of 25*l*., reducible to 20*l*. on compounding.

1062. My question was with reference to foreign students. Do they come in on the same terms with private students?—We make no difference in that respect. I may say that there is no great object in making such a difference, because the addition of their number to the school has not hitherto necessitated any addition to the staff, and therefore their being away would not diminish the expense of the school *pro rata*.

1063. Are you acquainted with the École du Génie Maritime at Paris?—Yes.

1064. The primary education there differs considerably from your school, does it not?—Yes; it pre-supposes a thorough knowledge of mathematics, both pure and applied, to begin with. In fact, the best pupils from the École Polytechnique generally elect to go to the École du Génie Maritime in preference to any other applied branch.

1065. Do you prefer having the students taught mathematics before you take them, or do you think it is desirable that the present system should be continued, and that they should be taught mathematics at your school?—I think, as far as concerns my instruction or the convenience of the teachers it is immaterial; it would certainly not be worth while to establish an École Polytechnique to suit the convenience of my school alone, but at the same time I think it would be an economy of public money, if the scheme were to be extended, to have one central mathematical school, and to send them thence to separate special schools at the end of their course there.

1066. The course of mathematics which your pupils pass through is not of so special a character that it would not be also useful to other classes of students, I presume?—There is a little that is special about it for the naval architect, and what is special would of course be separated from the general course, but with regard to what is taught to marine engineers, nearly the

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21 June 1870.



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21 June 1870.

whole of it would apply to any class of engineering, and a great deal of it is general physics.

1067. The French school which we have been speaking of is a very small one, is it not?—Very small; it embraces, I think, now about nine or ten students sent from the Government, two or three private students, and two or three foreign students.

1068. You consider that the course of instruction at the School of Naval Architecture might be rendered more useful to a more extended class of students?—Yes, the mathematical course and a great deal of the engineering course might.

1069. What are the employments or professions that you specially have in view?—The greater part of our course that is given to marine engineers is quite applicable to any class of mechanical engineers.

1070. If it were extended in this way it would bring you more into competition would, it not, with other educational establishments?—Unquestionably.

1071. Is it your view that such competition would have advantages?—I should hardly like to enter into the political question. We do feel already in respect of marine engineers, and to a certain extent with regard to shipbuilders, that there are some disadvantages from this competition with the system of articulated pupils. But the competition has not been serious enough at present to alarm the owners of large engineering establishments at all about their pupils' fees. I apprehend that we should meet with considerable opposition if that alarm became serious.

1072. Are there many private establishments where articulated pupils are received?—I think nearly all the great engineering establishments receive them: such, for instance, as Penn and Maudslay.

1073. They form a very numerous class do they not, as compared with the students at the Royal School of Naval Architecture?—I should think so: the ordinary entrance to the profession of an engineer is in that way.

1074. Have any of the articulated pupils also been admitted to your school, or have any of your scholars subsequently become articulated pupils?—I think not, at least not to my knowledge.

1075. (*Mr. Samuelson.*) What subjects do you yourself teach in the School of Naval Architecture?—The whole course of pure mathematics there given, and also the special applications of it to some of the calculations of ships, chiefly calculations of displacement and stability.

1076. Have you a course of practical mechanics?—There is a course of applied mechanics and applied mathematics in the school, but that is taken by Mr. Cotterill, and not by myself.

1077. That, I suppose, is one of the classes which you think would be specially applicable to all mechanical engineering?—Yes, with a very slight difference indeed.

1078. You stated, I think, that the Inspector-General of the School of Naval Architecture is the sole examiner unless he should call in others to assist him?—Yes, exactly so; he is responsible to the Science and Art Department for examining the school and reporting the results.

1079. Does he in practice call in special examiners to his assistance?—Yes, he does.

1080. Will you have the kindness to state in what subjects and who the gentlemen are that have assisted him lately in the examinations?—Mr. Reed, the Constructor of the Navy, has generally undertaken the charge of the whole of the practical shipbuilding, and nearly everything connected with it. Mr. Scott Russell, and lately Mr. Reed's department have set papers in steam. A portion of the more special application of steam and applied mechanics has been taken by Professor Rankine of Glasgow, the chemistry has been undertaken by Dr. Frankland, and Dr. Percy has examined in metallurgy.

1081. Do those gentlemen report to the Inspector-General, or to the Science and Art Department direct?—I presume they report to the Inspector-General, but my knowledge of that is not direct.

1082. Your school at present is held in temporary buildings, is it not?—It is.

1083. But it is the intention, is it not, to remove it to a larger permanent building, of which laboratories form a considerable portion?—I understand that is so.

1084. Do you consider that removal to be absolutely necessary?—The present buildings are by no means satisfactory; they are too thin and altogether of too poor a construction, and I should doubt if they would stand many years.

1085. But as regards the internal space of the apartments, are they adapted to the purposes of such a school as the School of Naval Architecture?—We have all that we want in that respect as a temporary thing; the worst part is the laboratory.

1086. The class rooms are large and light and well ventilated, are they not?—Fairly ventilated. The walls are too thin, so that we cannot get steady temperature and good ventilation in them. We have four class rooms altogether, about 18 feet by 30 each, and some smaller rooms as offices.

1087. You have spoken of the École du Génie Maritime in Paris; is that the only school in which the naval architects of France are educated; in which the higher class of naval architects are educated?—There are also what they call Écoles de Maistrance in the dockyards.

1088. Those schools are for foremen, I suppose?—Yes.

1089. At present the education of naval architects and marine engineers in private practice is chiefly conducted in the shipbuilding yards and engineering factories of private firms, is it not?—Yes.

1090. Are the pupils articulated to the persons carrying on those businesses?—Generally, I presume so. As a matter of fact, a large proportion of the superior officers in those yards are persons who have actually been brought up in the Royal dockyards and left them.

1091. Do you believe that to be the case to a considerable extent?—I know it to be the case to a considerable extent, but to what extent I could not say.

1092. Are you speaking of naval architects more especially on the Thames or throughout the country?—Throughout the country; not so much in Scotland.

1093. In those private establishments do they receive no theoretical instruction?—They generally contrive to get a little as a matter of private arrangement with the chief draughtsman in the yard.

1094. Do you mean instruction in drawing or in more purely scientific subjects?—Chiefly in what relates to the theory that directly bears upon their profession; what is called "laying off" in a shipbuilding yard. A private student, if he is active and energetic, and wishes to learn his profession, generally gets assistance from the chief draughtsman in the yard in that respect.

1095. Is there anything analogous in reference to the students of marine engineering?—I do not know; I fancy not. I fancy the office in a shipbuilder's yard is more distinct from the work, moreover the laying off being a branch of descriptive geometry which hitherto has been but little studied in England, is of a very special character, and they therefore can only get it from one person in the yard, and probably would have to pay him extra for it.

1096. As far as you are aware do the pupils of marine engineers in private practice obtain no theoretical instruction as a part of their apprenticeship course?—I would not undertake to say that; they get a good deal in the actual office work of an engineering office, much more than they would in a shipbuilder's office.

1097. In what way?—In drawing, and in getting out the drawings, a business which is not specialised in an engineer's office in the same way as it is in a shipbuilding yard.

1098. Do you mean that they are taught, for instance, to calculate strengths from theoretical considerations?—I should think in order to get accurate information upon that, it would be better



to examine marine engineers; but I know that in a naval shipbuilding office, unless a boy is specially put under the care of a draughtsman, he simply goes to the commercial part of the office, whereas in an engineer's office a boy is generally set to drawing at once, and he is afterwards taken out to help to superintend the practical work, in the course of all of which he has to make certain calculations for himself which he has to get corrected if he cannot do them properly.

1099. Is it within your knowledge whether the pupils of marine engineers or of naval architects are frequently instructed in science in some college?—I know that a great many of them are, more especially in University College and King's College, because they are enabled to get through the courses of the London University much earlier than Oxford or Cambridge courses. I presume they take their degree from the London University.

1100. (*Professor Huxley.*) You meant the London University, not University College?—Not University College especially, certainly not. I mean chiefly that they pass through either University College or King's College, or some of the establishments in the country affiliated to the London University, the students from which may take a B.Sc. degree in the University.

1101. (*Mr. Samuelson.*) They desire to take a degree in the London University before they enter upon the duties of their apprenticeship?—Before or shortly after. They very often go through the course of either University College or King's College, and then of course it is a question of their own discretion whether they will choose actually to take a degree.

1102. Are you aware whether they continue to follow the courses of either of those two colleges at the same time that they are serving their apprenticeship?—I have but a very small acquaintance amongst engineers. I certainly have known one or two young men who have done so.

1103. With reference to shipbuilders, is there anything of that kind prevailing?—I am in the same difficulty with regard to the private shipbuilding trade. I have seen most of the great yards of England, but I do not know very much of what goes on in them.

1104. You know more of the superintendents than you do of the pupils?—I know more of my own school than I do of the trade generally. I have frequently taken introductions from gentlemen in the Admiralty to so-and-so who used to be a dockyard man, but who now is in so-and-so's yard.

1105. (*Dr. Sharpey.*) With reference to the establishment over which you preside, have you considered whether it would be better to retain the present system of including in one course of instruction all the preliminary scientific branches, such as mathematics, physics, chemistry, and so on, or to confine the instruction in the School of Naval Architecture to the application of those branches, and require that the students should obtain a previous training in another establishment or elsewhere?—I think as far as the result is concerned that it is indifferent. I think that it would not be worth while to establish a separate mathematical establishment simply to feed the School of Naval Architecture. If there were many such schools to be fed it would be an economy to have a separate school of mathematics and general physics.

1106. Might it not be practicable for students to obtain that information elsewhere in existing establishments?—I do not think in the present state of education that we should practically get it. I would have taught less mathematics if it had been possible.

1107. Do you think that that could not be got elsewhere and then tested by an entrance examination to your school?—I think it could not be got unless the Government would consent to the establishment of some place of general mathematical and physical education like the *École Polytechnique*.

1108. (*Professor Huxley.*) I observe in your *précis* a remark upon the one-sided character of the education of students in the College of Chemistry and

School of Mines from want of mathematical and general instruction; will you be kind enough to make any statement that you wish to offer the Commission upon that point?—My impression is that, generally speaking, if you take a young man from the lower middle class with the ordinary education that he brings out of school, or even a little above the class of such a school, and you then give him three or four years' instruction either in the School of Naval Architecture, the School of Mines, or the School of Chemistry, when he leaves these he will come out having gone through the course, but deficient in the general education that is needed to give breadth to his knowledge even of the subjects which he has learned. I have heard complaints of this nature from the employers of men who have left both the School of Mines and the College of Chemistry. With regard to the College of Chemistry, one or two cases have fallen under my own notice, but I should not like in those cases to distinguish between what is due to the school and what to the personal peculiarities of the individuals whom I have met.

1109. You have doubtless heard that the want of a chair of mathematics at the School of Mines is a want that has pressed itself upon the professors of the School of Mines, and that they have made repeated applications to the Government to be provided with one?—I have heard so.

1110. What suggestion would you be disposed to make in order to supplement the want in general instruction which you have observed in the students of the College of Chemistry and the School of Mines?—The only one that I can conceive of is to give them a preliminary course of general study, including especially mathematics and general physics.

1111. What do you mean by general study, does it include mathematics and general physics?—Yes.

1112. What public school, or what school in England would you send those persons to in order to get that combined with their general education?—I think it would be necessary to establish a special school for the purpose.

1113. There is no school now existing in which that instruction could be got?—None occurs to me.

1114. You are aware as far as the School of Mines is concerned at any rate, a considerable proportion of the young men who come to study there are people who have had what is commonly called a fair general education, such as is given by our English schools?—I am afraid that in this country, as far as accurate information is concerned, a fair general education means very little indeed.

1115. I should entirely agree with you, but still they have got what is to be had; that is to say, taking what the education in this country in the ordinary school is, they have had as good an education as the middle class commonly gets?—Of course I have had no experience of what class of students they get at the School of Mines: my experience is that outlying establishments, especially somewhat new establishments of that kind, are very apt to attach to them a class of persons who have failed in either getting into other pursuits or in getting on in them when they have started in them. I think we do not get in those public schools the best men, and I do not think we get the best educated men.

1116. Have you paid sufficient attention to the course of education for the examination which is required for an associateship of the School of Mines, to be of opinion that the persons who have failed in other things are likely to get through that?—No, I should think they would not be likely to get through that, but you have probably had a considerable proportion of failures.

1117. You may have heard that the proportion of failures is not greater than it is in any other school whatever?—I had rather not answer any more questions about the School of Mines, with which I am not directly acquainted.

1118. (*Dr. Miller.*) If I understand you, the School of Naval Architecture is chiefly designed for the pur-

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21 June 1870.



C. W.  
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21 June 1870.

pose of giving instruction in applied mathematics?—It is intended to give the complete theoretical course required to supplement the course of practical work given to the engineering students of the royal dockyards, and to the shipwright apprentices.

1119. But I understand you that there is nothing in the course of the naval school which would prevent a course being given that would give general instruction in science?—Yes; there are some special courses which are given to shipwright students, and some little that is also special to marine engineers, but so little in the latter case that the marine engineers' course would almost apply to the course of any mechanical engineer.

1120. But I understand that you are anxious to invite not merely naval architects and engineers, but engineers generally to the school?—No; we have made no attempt to do that. I say that the course is from the necessity of the case nearly as well fitted for a mechanical engineer as it is for a marine engineer, but we have made no attempt to get mechanical engineers into the school.

1121. My question was whether your course was not, in your opinion, equally well adapted for both?—I think so, very nearly, though of course they are applied differently.

1122. Then, as I understand you, the title is nearly accidental, and the name "School of Naval Architecture" happened to be given to it because the Admiralty sent a certain number of students to attend the courses?—The primary object of the school was to meet the wants of the dockyard, and to be a school of marine engineering and naval architecture; but iron shipbuilding and the use of steam propulsion have made so much development in this country, and marine engineering differs so little except in the size of its cylinders from mechanical engineering, that it has practically got into a form which would be equally well adapted for mechanical engineers.

1123. I think I understood you to say that it costs about 100*l.* a year for a student to take the instruction which is given in the school?—No, I am afraid that has not been expressed quite distinctly. I said in my précis that the cost is a little over 3,000*l.* annually, but in point of fact I find that it is a little under 3,000*l.* exclusive of the maintenance of Admiralty students. That cost of maintenance is rather less than 100*l.* each for those students.

1124. What is the cost in the school?—The cost of tuition in the school and the expenses of the school would be about 67*l.* each student.

1125. That includes instruction in applied mathematics, instruction in applied mechanics, instruction in the strength of materials, and instruction in the applications of heat, does it not?—It includes those, but it also includes a course of pure mathematics (of which the syllabus is not yet prepared), and also chemical work in the laboratory, and the privilege of attending courses of lectures.

1126. Did I understand you to say that there was no institution in the country where general instruction in science can be obtained?—No, certainly that was not my meaning.

1127. But is it a fact, as I understood you to say, that it is necessary to make a new school for the purpose of giving general instruction for students who are to come to this school?—Because I doubt whether you could get it for the middle classes. The higher classes, of course, may be presumed to afford to get the education somehow, but I do not know any school from which the average of the scholars turn out with the knowledge of mathematics which my advanced pupils actually do.

1128. Do you know what is the expense of an establishment with which I happen to be acquainted, namely, King's College, with regard to applied science?—I do not.

1129. You do not know that it is about 45*l.* a year for each student, and that that includes not mathematics only, but it includes mathematics and various branches

of physics and chemistry?—I have never had any great acquaintance with King's College.

1130. May I ask you whether in this case your school fees which are given go into the Exchequer?—Three tenths of the fees of private students come to me, and two tenths go to the vice-principal, and the remaining half is paid into the Exchequer, unless the Treasury, as they did in the first year or two, have allowed it to be diverted to the general purposes of the school.

1131. (*Chairman.*) Could you give us any special facts illustrating a remark, that I see in your précis, namely, the tendency of men who have failed elsewhere to get into new institutions and thereby to damage their credit, is that with regard to anything which has occurred with reference to the School of Naval Architecture?—Yes, I have had continual applications from parents to get in persons whom I found to be utterly unqualified for coming into any advanced school of science from the want of previous information, and one or two who have attempted to get in with damaged characters. I do not think that my school has taken much harm from that, because I think I have been pretty successful in keeping them out.

1132. You do not think the evil of any serious extent?—No, I merely meant that it must be taken account of in judging of the results of most new schools. In many cases I could see quite distinctly that a young man was sent up to my school to try if I would take him, or if I could usefully take him, simply because they could not find anything else suitable for him.

1133. Have the pupils from private schools entered themselves at the Royal School of Naval Architecture with a view to become generally mechanical engineers?—I could hardly answer that question, because I think their views when they come to me, are somewhat vague. They hope that they will get an education which they will be able to make use of.

1134. Do the Government students for the greater part go into the Government service in the dockyards or elsewhere?—As a rule all of them; in fact they are public servants the whole time they are in my school.

1135. But they are at liberty, are they not, if they please, to leave the Government service?—I think not. One of them accepted a surveyorship of Lloyd's, and was strongly censured by the Admiralty for accepting it without their previous permission.

1136. What age are they generally when they leave your school?—About 22, I think.

1137. Are they legally bound in any way to the Government, or is it only that they are morally under an obligation to the Government, to enter their service?—They were, I think, only morally bound after the completion of their apprenticeship, but I understand that there has recently been talk of taking a bond from them, but whether this has been actually done or not I cannot tell.

1138. Your précis includes a great number of other heads upon which I have not, or any other member of the Commission, asked you any questions; it is a very wide field certainly, and I think the opinion of the Commissioners generally is that they would be glad if you would draw up a statement on paper explanatory of your views upon the subjects to which I refer, such as teaching generally scientific instruction, and instruction in physical science?—I should almost prefer not doing that. My only reason for putting this down in my précis was for it to serve as a basis on which you might examine me if you thought proper, and not to ventilate any views of my own on the subject; I was obliged to draw it up quite at random, and I put down all that I thought of.

1139. (*Mr. Samuelson.*) You have spoken as to the want of mathematics in the preparation for the College of Chemistry and the School of Mines; is it not the case that not only are the pupils who come up to those schools deficient in mathematical instruction, but that they receive no mathematical instruction in those



schools?—That is a question that I cannot answer from my own knowledge. I believe it is so.

1140. (*Dr. Sharpey.*) May it not be shown by examination at entrance?—My experience in my own school is that any examination at entrance would have the effect of keeping out students rather than ensuring the knowledge.

1141. (*Mr. Samuelson.*) You believe that there is no mathematical instruction in the College of Chemistry and the School of Mines; in the School of Naval Architecture your chemical instruction has been insufficient, and you have endeavoured to improve it by an arrangement which you have made with the department of chemistry, in the School of Mines?—No; with Dr. Frankland's school, the College of Chemistry, in Oxford Street.

1142. Which is a department of the School of Mines, is it not?—I do not know that.

1143. In your opinion would it be possible, on the other hand, for the School of Mines to make a converse arrangement with you for instruction in mathematics?—Undoubtedly. It would probably be necessary to increase our staff if they sent us men, whose education differed very materially from the men that I have to deal with, or if they came in considerable numbers.

1144. (*Dr. Miller.*) What is the meaning of this note in the précis of your evidence, "System of *répétiteurs*, as used on the continent, has been found necessary here for continental students?"—I dare say you are acquainted with the system of *répétiteurs*.

1145. Will you state it to the Commission?—The general system of instruction in the higher colleges in France is to get a first-class lecturer, who delivers a lecture lasting perhaps from an hour to an hour and a half to a large body of students. It then becomes necessary for the college to take practical means of seeing that that lecture has been really and usefully mastered, and for that purpose they have a staff of teachers who are called *répétiteurs*, who take students either singly or in groups of three or four together, and examine them in detail upon the subject, and see how far they have really mastered what has been taught, and give them such additional explanations as they may need.

1146. But why do you say that it has been found necessary here for continental students?—Because, although our lecturers have generally made their expositions sufficiently easy to be comprehended by English students, the continental students were not sufficiently acquainted with our language, especially with our technical terms, and our way of viewing the subject: this has rendered it absolutely necessary to engage a former student of the school or some other person to go through it with the foreign students, because we find otherwise that they merely sit at the lecture, understanding nothing whatever about it.

1147. Do you approve of that yourself?—Yes, decidedly, and I think that if we had a system of extensive technical lectures it would even be necessary for the English students, and for that reason in my own teaching I find it necessary to use lectures but very little, and only to supplement the books, but not to make it a substantive part of my method of teaching.

1148. In fact, it is catechetical instruction that you give in that respect?—It is. I generally take the students through a regular text book, like Todhunter's Differential Calculus, and if I find that they are not getting on fast enough, or that they fail to understand any of the principles, then I go back and give them short lectures at intervals of a few days, upon the points upon which I have discovered that they want a little special teaching.

1149. (*Professor Huxley.*) I presume you would not apply that to the teaching of all subjects?—No, chiefly the subjects requiring a good deal of thought, such as mechanical and mathematical lectures.

1150. I perceive that in your notes you say, "Hence in this school lectures are only used occasionally to

supplement the text-books," to what does that refer?—I am speaking here of lectures on mathematics and applied mathematics.

1151. (*Chairman.*) Are there any other matters connected with the School of Naval Architecture upon which you would wish to make any additions to your evidence?—I should like to say something with regard to the instruction in chemistry. The instruction in chemistry has hitherto been very unsatisfactory, I fancy chiefly from the very small amount of time that it is possible to bestow on it, and also from our being so far detached from the College of Chemistry. It is not a subject which I could attempt to superintend myself, but I find that we have actually had these defects—that the students have generally gone through only a small laboratory course, and that laboratory course has been very little else than one particular rule-of-thumb method of analysis, the consequence being that the students, though they are able to find out whether there is iron, or copper, or nitric or sulphuric acid in a particular mixture, have very little actual knowledge of chemistry. We have now arranged that it shall be supplemented by lectures; but still I think the paramount defect is that the laboratory course will be insufficient, and probably pretty much in the same direction as before; that it will result in one specific method of analysis rather than in a real knowledge of chemistry.

1152. (*Dr. Miller.*) 20 lectures are to be given; do you consider them insufficient for that purpose?—I should consider it quite sufficient with private reading for a general knowledge of chemistry, but still I think the laboratory work, inasmuch as it would involve analysis only (and a very little of this suffices) would be unsatisfactory, and I think it would be impossible to remedy it until the School of Naval Architecture and the College of Chemistry are brought so close together that the students can conveniently attend the laboratories of the college, for as long as the chemical part of the School of Naval Architecture is so small as it is at present I do not see my way to any cure.

1153. (*Chairman.*) Are there any duties of an educational character connected with your appointment as superintendent of the Naval Museum?—None whatever; it is a mere keepership.

1154. Do you make use of it at all in connexion with the School of Naval Architecture?—Yes, we sometimes take the students in there to point out special practical applications, or anything of that kind, and we occasionally borrow some of the models, especially models of the details of ships, from it.

1155. (*Mr. Samuelson.*) Do you find the Patent Museum of any service?—Occasionally we use it in the same way, although less often.

1156. (*Dr. Sharpey.*) What are the duties of the vice-principal?—He takes care of the teaching.

1157. What branch?—He takes the applied mathematics, and the applied mechanics.

1158. (*Professor Huxley.*) Is there any distinct career open to the persons who pass through the School of Naval Architecture?—Only to those who are in the Government employment before they come to the school.

1159. Then there is a career for them?—Yes, they generally get to be foremen of yards, or to be employed in the Draughtsman's Department of the Admiralty, and the engineers go and serve as engineers in ships.

1160. Supposing a young man came from anywhere and went successfully through your college course, would not the fact of his having gone successfully through it give him some chance of a Government appointment or the like?—None whatever, I should think, unless as a very exceptional case indeed.

1161. (*Chairman.*) Was the course made one of four years very soon after the establishment of the school?—Just about the time the first scholars left us after their course of three years.

1162. Then only about two or three sets of students at present have left the school?—Only one set of students has left us after a four years' course.

C. W.  
Merrifield,  
Esq., F.R.S.

21 June 1870.



C. W.  
Merrifield,  
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21 June 1870.

1163. Are all the Admiralty students employed in the Government dockyards?—One, as I said before, has left and become a Lloyd's surveyor, and another, one of the engineers, is now in the Civil Service of India, in the Works Department.

1164. Has the number annually admitted been fixed upon any calculation of the number likely to be annually required for the Government service?—I have no information upon that point; it is at present fixed simply to give an average of 30 to the school.

1165. Are you able to say whether those who have already left the school and are employed in the Government dockyards are giving satisfaction?—I

understand that they are giving very high satisfaction.

1166. Are they a superior description of servants to those who were previously employed in the same positions?—At least equal to them, and superior in education. I must say at the same time that this is not entirely due to my school, but partly also to selection and training before they come to my school. They only send me the very best.

1167. Have you anything personally to do with the selection of students?—Nothing whatever.

1168. You do not go to the dockyards to select them from the dockyard schools?—No.

The witness withdrew.

Adjourned to Friday next at 11 o'clock.

REFERENCES (supplied by Mr. MERRIFIELD) to Reports on Royal School of Naval Architecture in the Minutes of the Science and Art Department.

Report by Capt. Donnelly and Dr. Woolley on the school:

Vol. 12 for 1864, p. 67.

Prospectus (original) of school, do. p. 70.

Report by Capt. Donnelly and Dr. Woolley on the French School of Naval Architecture, do. p. 72.

Report by Dr. Woolley on Royal School of Naval Architecture (on its actual establishment), p. 83.

Reports by Dr. Woolley on Royal School of Naval Architecture.

Vol. 13, for 1865, p. 64.

Vol. 14, for 1866, p. 61.

Vol. 15, for 1867, p. 81.

Vol. 16, for 1868, p. 145.

Report by Mr. Merrifield on the same:

Vol. 16, for 1868, p. 149.

No. 6, Old Palace Yard, Westminster, Friday, 24th June 1870.

PRESENT:

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D., Sec. R.S.

Dr. ALEXANDER WILLIAMSON, F.R.S., examined.

1169. (*Chairman.*) I believe that you are Professor of Chemistry at University College?—Yes, I am professor of chemistry and of practical chemistry.

1170. And you are also President of the Chemical Society?—Yes.

1171. The study of science is a subject to which you have paid great attention?—Yes.

1172. The Commission will be glad if you will have the goodness to explain to us the results at which you have arrived on this subject. Perhaps you will tell us in the first place whether you consider that the system of teaching science should vary in any degree according to the objects for which science is studied?—From all that I have seen in that matter, the attempts to vary the method of teaching so as to adapt it in each case specially to the final object, I am certainly led to the conclusion that those variations are inexpedient, and that the effect of them is to teach rather less good science than would be taught if the final application were not kept in view particularly at the time. I am often at University College applied to by parents and sometimes by future students who want to learn, not scientific chemistry, but chemistry as applicable, for example, to brewing, or a particular kind of chemistry that is applicable to cotton printing, or to some other business or manufacturing pursuits. I tell them that I do not know two sorts of chemistry, there is a difference between explaining in an ac-

curate and intelligible way simple phenomena, and exercising the minds of the students upon them, and going at once into complex things which we cannot so well explain, and which teach the methods of science less accurately than those more simple ones. The result of my experience has led me to believe that it is most useful for brewing purposes or for cotton printing purposes to learn accurately the properties of the elements and the way to make experiments accurately and to elicit truth by experiment; if we give them those habits as efficiently as possible, and they afterwards go and learn their practical operations in a place where they are carried out successfully for commercial purposes, as in a brewery or a cotton printing works, they do best.

1173. Are you of opinion that the industrial applications of science cannot be well taught in schools and colleges?—I think, as a rule, not. I think that when one attempts to imitate in a school the practical operations of a manufactory, one succeeds in showing the way not to do it. The difference between such imitations as we can carry out and the actual thing is so exceedingly great that I think it is wasting the time of a young man to study the imitation; and the system has this further evil, that students are led to fancy that the final practical problem is much easier than it is. When we attempt to do that sort of thing we really deceive them, because in practice an immense number of considerations bear upon the

Dr.  
A. Williamson,  
F.R.S.

24 June 1870.



final results, such as the price of articles, and the powers of the workmen, and many other things of which the due direction is necessary for the success of the operation; so that our imitations in a laboratory or in a school are imperfect in themselves, and they mislead a young man. We cannot turn out products as they do in a factory. It is just wasting the time of students instead of doing that which really might be of permanent use to them, and they are sent out as conceited fellows, who are simply a nuisance to the factory, if they do work in it, instead of modestly beginning to learn the practice at the bottom. That is the experience, I believe, in most places where the experiment has been made. Certainly on the continent as well as in England I have heard practical men state that opinion in very strong terms. Many times I have been told by foreigners who know something of our system of apprenticeship, and the French and German system of professing to teach industrial applications in schools, that we are much wiser than they are in that matter, because we know what practice is, whereas they attempt to give in the schools an epitome of it, which is unsuccessful; only they do not know the defect of our system, that young men go into their apprenticeship without a previous training in science. What our own manufacturers complain of, and suffer from is, that young men really do not prove so valuable as they expected in the works because they had not got that proper training in the science, and that knowledge of facts which we ought to have given them beforehand.

1174. What are the conditions which in your opinion are requisite for an earnest and effective study of science?—There are a great many; but I think one thing is particularly important, that students should come in contact with people who are earnestly devoted to science, and who set the example of working at it in a right spirit. I think if I were to name one thing alone it would be that; of course there are many other things which tell besides that, but the force of earnest example is I believe almost more than any one thing, that the teachers should work at science earnestly, with a love of their subject, and for the sake of mastering it, for the pure love of it. Of course the intellectual power of the teachers, in aiding the student to overcome difficulties, and in training their mental powers, tells immensely. The teacher ought to select methods in which he really can best train the powers of his pupils, to make them do a certain thing that can be done in a perfect way, then let them practise such knowledge in proportion as they get it, going on to more complex and more difficult studies, of course, as they are able to do so. I think one great disadvantage which in England the study of science suffers from, is the want of popular sympathy with it. Science is not as a rule appreciated for its own sake. I am well aware that there are many persons who do so appreciate it, but in England the one thing which is generally appreciated is making money directly, and people do not believe that science is of any use for that end. They say you are a set of dreamers; and that science is a sort of amusement and not real work. They do not believe that it is of actual use in money making, and they do not value it for its own sake, as they ought to do. I think that tells immensely upon students. When students are working well at their studies for a while, perhaps their father or their uncle says, you must not be going on with that, you must be getting to business, you cannot be going on playing so long. They do not believe in science; they have no real faith in it. And yet those who do get a little faith in it, and work on, certainly as far as my small experience goes, are amply repaid. They do far more than others do while they are at it; and when they go into practice they distance everybody. I think that one reason why sufficient earnest concentrated attention is not given by students to science, is that their teachers are not in the most favourable position for doing what they would wish to do for them. They are themselves a good deal called away by other things, from

teaching functions and investigating functions. They are not, as a rule, placed in a position really favourable to the most effective exercise of such powers as they possess.

1175. Are you prepared with any suggestions for encouraging the study of science for its own sake?—The particulars I should feel great hesitation in recommending, but there are some general relations of science to the State which I think would be likely to command general assent, and which I think might be made the basis of a plan of which the particulars would do what one would want. Whereas the State does not at present by any of its acts, as far as I know, acknowledge pure science as an element of national greatness and usefulness and progress, I think that it ought to do so. I think that whatever may be the conditions which, upon a due examination of what is needed for science, might be found most conducive to the development of a system of scientific teaching and research (I mean the material conditions in the way of funds), the Government should supply, so as to utilize such powers as there are in the country. At best, I think, those powers would be far less than what we need in order to do justice to such a task, and if you had all your resources well utilized, they would still be less than what you want. I think that free competition among all schools is really the main element of progress; they should be placed in a condition to be able to work to the best of their powers, and then let their progress depend upon the success of their work. I think it is most important that the Government should hold a neutral and impartial position, and not be partial to any one or other theory of science or science teaching, and not give special favour to any one or any other, but allow them all to work themselves out, and let the public judge of their relative excellencies and defects, and let them modify themselves in a free manner.

1176. Can you point out any principles upon which, in your opinion, Government aid or encouragement ought to be afforded?—I have thought of several principles, but whenever I dwell upon any one in itself, I am led to fear that it would be imperfect, and in some respects, perhaps, mischievous in its action if applied alone. Any one principle alone, I think, would at least be hazardous. For instance, the number of pupils who attend any professor or who attend any college is, I think, a circumstance which ought to have weight, but I am not prepared to say that it would be desirable to decide by that alone; on the contrary, I think in many cases it would be decidedly an evil. As an illustration of that, there are two very distinguished professors of natural philosophy at Edinburgh and Glasgow respectively. Professor Tait, at Edinburgh, has large classes, and his activity has been chiefly in the direction of teaching; whereas Sir William Thomson, at Glasgow, has comparatively smaller activity of that kind, for he works more at research, and to aid Sir William Thomson less than Professor Tait, on that account, would be obviously very undesirable. I should think it desirable that the numbers taught should be one element of the question that would weigh in deciding the aid, but also that other considerations should have weight if required; success in examinations should have some advantage. Then also the power of utilizing the advantages and opportunities for research, I think, ought to be considered. I think if an opinion could be obtained, as in many cases it certainly could, whether aid in the way of research is likely to be useful to a given man, that ought to be considered as one of the conditions for aiding him in it.

1177. Do I understand you to state that you do not desire the Government to establish institutions of its own?—I cannot well conceive any arrangement under which there could be free competition in the face of such an arrangement as that. I think the first thing of all is, that the Government should be impartial, and not be a party in the competition, as that would annihilate all competition, in fact, I do not see how it could come to anything else; the

Dr.  
A. Williamson,  
F.R.S.

24 June 1870.



Dr.  
A. Williamson,  
F.R.S.  
24 June 1870.

Government schools would receive aids which would practically annihilate the competition of others, and I think that for the progress of science in those schools, that would be most undesirable, and that nothing would so lower the eminent men who would no doubt be selected for such schools, as to give them special advantages over others, or that would so much diminish their real chance of highest usefulness in their work, as giving them exceptional advantages, putting them into a hotbed in fact. I think it would not be possible to do such a thing without serious evil.

1178. In your opinion, ought Government to afford aid on a considerable scale for the encouragement of science?—I should in any matter of money, recommend government to proceed slowly and gradually, and as far as possible to judge of the next step from the result of the previous step, and not to give hastily to the very best system an immense expenditure of money; but the main thing would be to spend money where it would promote growth and development, and to judge by the progress that it made how far further aid should be given; that would be the kind of thing that I should prefer. I think that that would be the wholesomest and the best in every way, and the most frugal of the expenditure of the public money, for the interests of the State are really the same, if you look at them in a general way. I should certainly wish in that way that the expenditure should come to be very considerable, and the more considerable the better; and no expenditure of public money could be more useful, even on the largest scale, than money that brought fruit in the way of extending knowledge and disseminating it. I could not conceive of a more thoroughly profitable investment of public money, if made in a really careful way.

1179. At the present time are there many institutions in the country which you think Government might well determine to assist?—I think so.

1180. Is there any principle on which you would select those institutions which are deserving of Government aid?—I think that for any practical matter like that, a single principle would be difficult to lay down. I think a certain combination of various considerations would be needed, and that some of the considerations, such as those which I mentioned a little while ago regarding the extent of their usefulness in teaching, ought to be very prominent. The only thing is not to take too one-sided a view of usefulness, but to include, as far as possible, the various elements of real usefulness; or, perhaps, in doubtful cases, or in cases where there was not such tangible evidence of usefulness, opinions might be got from competent scientific or learned bodies.

1181. Do you think that a certain number of Government scholarships could be established with advantage?—I should be very glad to see, in schools attended by the poor, aid given in the way of scholarships to those pupils who prove themselves to possess the ability of profiting by more instruction. I think there would be hardly anything more important than to distribute something like scholarships throughout the popular schools, I mean the schools attended by the poor in the country; so that one would have the best means of cultivating each youth in proportion to his power of profiting by such cultivation. I am sure that the accession of intellectual power that we should get in that way, would be something of incalculable importance.

1182. Are you of opinion that the Government ought to lend assistance in providing apparatus and books, and other facilities of that kind?—I think so. I think, certainly, in the higher scientific instruction it should be a *sine quâ non* that some material aid of that kind be given. In fact I do not know that in any country the teaching in the higher branches of science goes on favourably without it. Certainly in Germany and in France very great aids of that kind are given. In England where there are colleges of considerable activity, without such aid they certainly suffer very greatly for the want of it, and they are limited in their usefulness by the absence of conditions of that

sort, which are always supplied elsewhere. In fact, my French and German friends, when they hear of our establishments, will not believe it; they say, "You are joking, it is impossible," it is so different from the state of things in their own countries.

1183. Do you think that if public interest were taken in this subject sufficient to induce Government to come forward and render more assistance than it does now, this would imply a condition of things in which additional assistance from private sources might be also expected?—Quite so. In the first place, I think it would be certainly right that the Government should to a certain extent be regulated by public evidences that the thing is appreciated, and then if the Government did lend the sanction of its authority to the teaching of science as a useful and important thing, I think the fact of their doing so would encourage private individuals to do more than they now do in the matter. I think that the official sanction would fructify considerably in that indirect way, and would also encourage young men to look forward to the pursuit of science as their career, which really at present is very seldom done. We have not the resources in the way of aid which we ought to have, if science is to be put in a more dignified position. Young men never look to it for a career, generally speaking, and it ought to be put in such a condition that they could do so, so that they could give their powers as well as give their money towards it, for we need all that. I do think that the Government ought to put it in a more dignified position, and acknowledge that it is a thing of importance to the State, and not leave it to take care of itself.

1184. Are you of opinion that the Government might encourage science by the bestowal of Government appointments upon those who distinguish themselves in scientific study?—I do think that they should encourage them, not from any opinion which the Government itself would form of their individual merits, but merely in such a way as to increase their usefulness in their own work, and aid them as such by enabling them to do more and more useful work. I think that that really is the only proper way for Government to reward and encourage them, and not to give them appointments out of science because they are good men of science, or anything of that sort. I think that is utterly undesirable and unsuitable.

1185. You would not give them as rewards for science?—No; because they are good useful men of science, I would not take them out of science for some other pursuit, political or other; on the contrary, I would encourage their activity in science, and try to increase their means of usefulness in it. I think that that is really the only true way to honour them and encourage their usefulness. There is nothing more to be regretted than the contrary course which is adopted in some other countries, say in France, where when a man rises to a certain eminence he is taken out of science and put into the Senate. He is a very good man in science, but he may be a very bad senator, and I do not think it is an appropriate honour to him to put him in the Senate. It is a much higher honour to tell a man of science: you are doing most useful work, and it is our duty to help you to the utmost of our power in continuing this work on a grander scale.

1186. Are you of opinion that undue value is attached at present to examination tests?—In one sense I think that undue value is attached to them, inasmuch as it is practically supposed that they can decide everything. I believe that even more good than is now got from examination tests will be got from them in proportion as they are applied in a more judicious and accurate way. I think that examination tests are destined to do more and more good, but at the same time I do not think they ever have done or ever can do everything that is needed. The best of examinations can only test a young man's power of doing a certain particular work, which is just merely the work of answering questions under particular conditions;



and I do think from all that I have seen (and I have examined for a good many years at the London University and at my own college, and I have had still more work to do in teaching and seeing students' individual work), that a knowledge of what a young man has been doing during his period of study and how he has done it, if such knowledge could be obtained, would add very greatly to the means of forming an opinion of his efficiency for any particular position which he might wish to occupy.

1187. (*Dr. Miller.*) You are now referring, I presume, to college tests?—Yes, I refer to college tests.

1187a. (*Chairman.*) That is the distinction that you draw between mere examination tests and college tests?—Yes; it has happened to myself in an examination in the University College laboratory, that a young man whom I knew not to be the best chemist in the laboratory got the medal. It happened that I knew the handwritings, yet I was forced, upon the result of the examination, to give it to that young man who was certainly not as good as the one whom I had to place second to him, and who knew that he was not as good, and yet who had beaten him in that examination. It was a pretty long examination, lasting several days, and the one who got the medal went in in good health and spirits, and worked better than usual, whereas the other man was anxious and nervous, and did not work as well as usual. I had to go by the regulations and give it to the man whom I considered second. Of course, any system must be liable to some failures, but I do feel convinced that if a knowledge of what the young men had been doing, the work that they had been doing at the colleges or in the schools before the examination were taken into account, in addition to the result of the examinations, better materials would be obtained for judging of their qualifications for any particular work to which it might be desired to appoint them. Then the examination test alone, when applied as it is, is productive of one great evil, especially when examinations aim at directing teaching and profess to take the lead of teachers, and that is to call forth crams. I believe there has hardly any case of really good teaching been produced by examinations; what is produced by them is just a desire to pass the examination, and the systematic means adopted for that purpose are apt to be the most direct, and to degenerate into a desire to cheat the examiners, which is certainly a very degrading thing.

1188. But is there not a general impression that examinations secure impartiality, which it would be difficult to attain if you depended more on what you call college tests?—I think that even in examination tests partiality may show itself. For instance, in chemistry there are different theories, and if I am examining and happen to hold to one of several theories and to consider that it is very good and the others very bad, I am very liable to be partial to a young man who adopts my theory, however much I may struggle to avoid such partiality. I do not know that in the nature of the thing there is less risk of that in examination tests than in college tests. In a college test one has an opportunity of knowing more about the young men, but I do not recommend that college tests should take the place of examination tests. I do not think that examination tests are useless. I think they may even be made to do more good than they do now, but I am sure they cannot do everything; and I think that at present there is in the public mind a very exaggerated estimate prevalent of the value of examination, it is supposed to be all sufficient.

1189. Do you think that a system of college tests could be established on such a principle as to give confidence in the results generally amongst young men, that they would feel that justice was done to them?—I do not think that in any system you would be free from the risk of failure and flaws, of course, but I do think that with that allowance college tests could be systematized so as to command even greater con-

fidence than examination tests alone do now. There is one circumstance connected with that which I should beg leave to mention, and it is that if the Government were to aid institutions of which it takes no cognizance at present, I conceive that some inspection would necessarily accompany such aid, and that the Government would be bound to see that the money which they supply is usefully employed for the purpose for which it is intended. I could imagine that that function of inspection might be made useful for this purpose, that by a co-operation to a certain extent with the officers of the college the inspector might be cognizant of what the individual students are doing. But I think that it might most efficiently be done by combining the tutor's work with the professor's work. One ought to know what each student has done throughout the session. The final opinion should perhaps be a very little more than a statement of facts in a concise form; not only a statement that the student has been bodily present so many times in the class, but that he has done so much work in the way it ought to be done.

1190. Do you think that the duties of professor and tutor ought to be combined in the same person?—In small classes I think that that is naturally so; but when classes become large it is impossible to do that, and I think it is most important to give to young men who are destined to be professors some work in teaching under a professor. I think that that is the real way to train teachers; and that is really the only natural system of a normal school. It is the plan which I have in a spontaneous way acted upon for some good many years past, giving work in teaching to young men who have gone through the classes; and I have generally a certain number of them acting under me in the capacity of what I may call tutors. It is certainly a great advantage to the class to have them, and it is a considerable advantage to them that they should have such work. The subject of instruction they know pretty well; but if they are compelled to teach they get to know it better: then they come to me, of course, in every difficulty, and I render them all the assistance in my power. I do not think that the professorial system ever will attain its full usefulness unless completed or supplemented in that way. I could as soon imagine that a colonel alone without officers could effectually command a regiment, as that a professor could really conduct a large class without men under him; it would be perfectly unnatural and impossible. That is not an opinion of to-day; it is a thing which I have felt for a very long time, seeing the working of the present system, because we have tolerably large classes containing young men of very various aptitudes and habits, and the utmost that an efficient professor can do, is to address himself to the greatest number of them; and one tries to do it, but one knows that a good many are above what one is saying and a good many below it, and one cannot come sufficiently in contact with those by oneself alone to do all that they need. Sometimes a little more help in the beginning would prevent young men being discouraged, and cutting the class, which, of course, they do sometimes if they cannot follow the professor. If one had men in that way to watch each of the students, one would certainly keep the whole class going with a degree of completeness and efficiency, which is not possible otherwise.

1191. A tutor, you consider, should deal with them either individually, or at any rate in a very small number?—Yes, quite so; in small classes, in which he generally addresses them individually—that is the sort of way in which it usually occurs—occasionally addressing them collectively, but more commonly addressing himself to each individual student, and telling him the mistakes of his exercises or notes, or how to do an example which he could not master.

1192. Is that system in operation to any considerable extent in University College; have you tutors under you who are connected with your professorship?—They are not officially connected with me beyond this,

*Dr.  
A. Williamson,  
F.R.S.*

24 June 1870.



Dr.  
A. Williamson,  
F.R.S.  
24 June 1870.

it has just been an arrangement which I have made on a somewhat greater scale. The only systematic arrangement of the kind is this: at the beginning of this last winter session there was announced an exercise class of chemistry, conducted by Mr. Barff and some men under him, and that really is a case in point. But I have for many years past had an arrangement of the kind in a summer practical class, attended by a considerable number of students, who only come in for a small number of hours; the class consists of 40 meetings of one hour each, and there are 100 or 120 men in it. The working of the class is of this kind: I begin and teach them what to do, and how to do it. I walk about amongst them while they are doing those operations, and at the same time there are eight or ten assistants, each one having charge of a particular detachment of the class, and they act in that way as tutors, and then they get acquainted with them. I find that beginners who come into such a class get acquainted with those older men, and it gives them a better tone, it helps them on, and does them a great deal of good in many ways; and from that sort of practical teaching to those young men, I do not know which are the greater gainers, the tutors or the class. Perhaps the tutors gain even more than the class.

1193. In the précis of your evidence, with which you have been so good as to furnish the Commission, you refer to responsible reports; do you mean reports drawn up by the professors, or reports furnished to the professors?—I meant by that note a system which exists at University College, but which I believe only exists in one or two other places. When a chair is vacant in the College, the byelaws require that the Council shall send to the Senate the applications and testimonials of candidates for the professorship. Then the Senate appoint a committee of their own body, for the purpose of going over this evidence and of giving a responsible report of it. That report consists mainly of facts, classified in a clear and an intelligible way. They sometimes draw a conclusion from the evidence, and sometimes not; and upon this document the Council decides upon the man that they appoint, and the byelaws require that they shall have this document before them before they make an appointment. They are perfectly free to appoint or reject any advice which may happen to be given them, but they are bound to have this statement of the evidence before them. And really I do not know of any system which, upon the whole, admits of being developed so usefully as that one. I think it is impossible for anybody to judge of the fitness of several candidates if there are many of them, unless the evidence is in that way classified for him by some responsible persons. Of course this report is kept afterwards. I should say that if the Government were to make appointments by such a system as that which would admit of publicity being brought to bear upon it, and those reports upon which they decided were to be kept in archives where they could be accessible under proper conditions, it would be an exceedingly valuable means of gradually bringing the decisions to depend upon the evidence of fitness, and therefore that is what one would wish for. I think that that is one matter in which the power of the Government needs to be wielded with great impartiality, because even if they were to be quite impartial with regard to the aid which they give to schools, and yet preferred the pupils from one or another it would be like favouring the produce from one manufacturer to another, and I think that that would be a kind of partiality which would be very undesirable. I do not mean that it would injure the unfavoured schools, because that is of secondary importance, but it would be injurious to the promotion of science and the public service. In fact, the only views which I venture to form of any future system, are based upon what I conceive would be likely to be best in the public interest. I do not think one ought to consider the injuries which may happen to accrue to individuals or classes at present from any partial action of Government; but the question is, what system would be upon the whole

the best in order to get able and efficient men for the public service.

1194. Do you include among the public servants, men eminent in science?—At present I do not know whether they are considered as a class of public servants; I suppose they are not. If a man happens to hold an appointment under the Government he is considered a public servant, if not he is not; so that it would apply in the first instance to those who are, I suppose, actually appointed by the Government, but the functions of teaching are as public in their nature as any which could be named; therefore I do not know that it is particularly desirable to draw such a distinction. Among teaching establishments there are several which are governed by corporate bodies, and in Germany the States, many of them little States, give aid to such bodies in proportion to their need of aid, but in the main the aid from the State does not, as I am informed, interfere materially, or to any inconvenient extent, with their independence. They are acknowledged in that sort of way, and so they come to be affiliated to the State, and to be like State servants, and yet the governing bodies of the individual universities in Germany have a great deal of independence left to them. I should conceive that it might be desirable in developing any system in England, to leave as much local independence as possible to the existing bodies, at least as much as appeared useful for any good work that they could do, for after all that is the proper test.

1195. When the Government are desirous to obtain advice on scientific subjects, how do you think they ought to proceed?—I think it is a very difficult thing to give a specific recommendation, but I think that it must be undesirable that they should take advice which is given silently and without public responsibility being attached to it. Even although we would assume that the advice would be that of the best person who could be selected as an individual, I think that it is less likely to work well than if it were done in a more public way, and if it could be discussed also several days before being given. I should wish to see some responsible body selected in a proper manner, perhaps by some kind of elective system amongst scientific bodies, something like a scientific council, which should be referred to in matters relating to science or scientific instruction; and then that their action should be public. I think that the absence of publicity is very undesirable in anything of the kind.

1196. I think you have led us to infer that in your opinion institutions for the promotion of science supported directly by the Government are not desirable?—Yes, I think that any inequalities of that kind in the conditions, that is to say, where the Government pays one and not others, are inconsistent with true competition, and in every way injurious.

1197. Are we to gather from your evidence that you do not look with favour on the mode in which Government aid is at present applied; as, for instance, to such establishments as the School of Mines, the College of Chemistry, and the School of Naval Architecture?—The School of Mines I have looked upon as being something different in practice from that which it theoretically professes to be. It is a school of science really, and, of course, containing such eminent and earnest men, it does exceedingly useful and good work as a school of science; and I do not conceal from myself at the same time, that it must do useful work also as a special school of mines; but I really do not think that as a school of mines it justifies its existence. From all that I have heard, and my information is of course only partial and imperfect, I certainly think that it was a mistake to institute a school of mines officially, and I think that the working of it has shown that it is chiefly in other ways that it really does its best good—it does good as a school of science. I feel quite sure that such men could not work without doing good, but they would, I imagine, be far more useful if they systematically professed to be what they naturally



and really are, I mean teachers of science for its own sake.

1198. Do you think that greater results might have been obtained if the Government had given assistance to private institutions established by private liberality?—I believe vastly more. The natural system of a school of mines is for young men to go and learn, at a good college, those branches of science which are needed for mining, and then to go into the mines and learn mining there. That is the system which is frequently carried out by students. For example, I had some time ago a young foreigner who, after attending lectures at University College, went and studied coal mining. Mr. Warrington Smyth, the Professor of Mineralogy in the School of Mines, was kind enough to aid me in getting him introduced to a great coal viewer in the north, and he went as a pupil to this viewer, and his master expressed great satisfaction with the state of preparedness in which he came, and said that he learned in about a year as much as was usually learned in five years, and that was because he had had a thoroughly good college training and was able to understand the work far better. I do think that that is the natural way to do it.

1199. (*Sir J. Lubbock.*) Do you not think that elementary science ought to be taught in primary schools in this country?—I think that something of it must be taught, of course in a very elementary form, but the elementary facts and phenomena of physical science I am thoroughly convinced are destined to form an important staple of teaching in very elementary schools. Simple facts about air and water and combustion, and so on, I think are peculiarly instructive and delightful to young and old children.

1200. I presume that you would hardly think it worth while that they should learn those facts without the idea of their proceeding further in the study of science; just as it is desirable that all people should learn to read, with a view to the subsequent application of their power of reading?—I should like them to learn to read in any case, and, if they were able, to use that knowledge in the first instance in getting useful facts; by this work they would have more interest in it certainly.

1201. They would be more likely to keep the reading up in after life?—Yes, certainly.

1202. I presume that even in the poorest classes of life there are some men who have a great natural taste for scientific pursuits, which might be elicited and brought out if they had the opportunity of learning the elements of science in proper schools?—No doubt an immense number of capacities are lost now which would be utilized; in fact, the loss of national wealth in that way must be something incalculable.

1203. I gather that you consider that no system of national education can be considered as satisfactory unless there is some provision in national schools for teaching elementary science?—Quite so.

1204. With regard to the question of teaching science in our great public schools, do you think that that would interfere in any way with the literary studies of the pupils?—I am not so intimately acquainted with the particulars of the working of our great public schools as to be able to go much into that, but what I have heard and what I have occasion to see in various public schools (and I come in contact with the school masters frequently, having to recommend teachers to them who were my former pupils), is that a great many boys who now do not make any progress in literary studies, and who never get a habit of study at all, would be led into doing more, even in literature, than they do now, if they got habits of study in science, in fact things that are presented to them are often uninteresting, and they never get the habit of work; but if you began with giving them something like science, you would often lead them to literary studies which they would not otherwise get to. So that if you had only literature in view, I think the introduction of science would be desirable in schools; but I contend that as an intellec-

tual training it has a very high value indeed of its own, perhaps the highest if studied in connexion with literary matters.

1205. Do not you think that a variety of subjects is very desirable in school teaching, and that boys who have only two or three subjects get wearied, whereas if they had four or five they would be likely to learn two or three better than if they were confined to the two or three?—I believe that would often be so, for nothing has struck me more forcibly than the great variety and great differences of aptitude and taste amongst young men. I should like our school system to be as malleable as possible, so as to allow some boys, who might not be mentally quite like the average, to be taught upon a little different system. To have them all taught in one uniform type I do not think ever would be possible or desirable.

1206. If you had a variety of studies, would it not also happen that those boys who had the most scientific taste would devote more of their thought to science, and would learn more from scientific teaching, and get to the top of the class and get the prizes, and those on the other hand with literary tastes would do the same in literary studies, so that although the curriculum might be nominally the same, there would practically be a good deal of difference between those who had different tastes?—Yes, only I should not wish to force young men to do more than I found they could really do well. Some lads have the peculiarity that they can only work well at one thing at a time; it is a defect, but still some are so constituted, and they will afterwards work at another thing well and do several things successively, but not simultaneously; and I think that in our systems of instruction there is not usually made sufficient allowance for that variety of constitution of mind. I think it is right to give them the choice in the way that your question suggests.

1207. There are many, are there not, who would only work systematically at literature and not at science?—Yes.

1208. Therefore your remark would not apply to science any more than to literature?—No, it was not intended to do so.

1209. You made a remark in answer to a question of his Grace, with regard to the secret advice which is given to the Government; the Government generally consult the Royal Society on scientific subjects, do they not?—Occasionally I have heard that they have consulted the Royal Society, but I am not aware that any established custom exists to take the opinion of any scientific body on matters which relate to science. I fancy it is more constantly the practice for the minister or adviser of the Crown to ask the opinion of some able and accomplished gentleman who may happen to hold office in connexion with him; that is my impression. I understand that Mr. Cole has been very frequently consulted on matters of the kind.

1210. I infer that you did not intend to condemn the system of applying to the Royal Society for advice on scientific subjects?—No, that is rather the kind of thing which I wish to encourage. I referred to appointments, when they have appointments to make. I heard lately of the case of a young man who has been appointed to a position in Jamaica as a chemist, and I understood that he got it through Mr. Cole. Mr. Cole was asked to recommend a person for the appointment, and he applied to Dr. Frankland: of course he could not possibly have done better, and Dr. Frankland gave it to this young man. It is said that if you will go to the Government school you will get the Government appointments, and if not, not. How far that is true I cannot say, but that report is current.

1211. Then it was not altogether with reference to the course to be pursued in scientific questions, but more with reference to scientific appointments, that you were speaking?—Both; for instance, whether it is desirable either to institute schools of a particular kind, I am not aware that that question comes before any of the scientific bodies. It is reported that a large laboratory is being built at South Kensington,

Dr.  
A. Williamson,  
F.R.S.

24 June 1870.



Dr.  
A. Williamson,  
F.R.S.

24 June 1870.

and I am not aware that that came before any scientific body at all, it was by mere accident that one heard of it.

1212. You approve, do you not, of the system of appealing to the Royal Society?—Yes; because it comes before a body who would give advice publicly, and I think that that would be most desirable: whether it should be that particular body or some body selected for the purpose is another question. I have no doubt that in cases where the Royal Society has been consulted, it has given advice with great care and conscientiousness.

1213. Do you think it undesirable that such a step as the erection of a very large laboratory should be taken without giving some recognized scientific body an opportunity of expressing an opinion upon it?—That any such step should be taken silently I think very undesirable. I cannot see anything to recommend it, I mean its being done silently and secretly.

1214. I presume when you said that you did not think it desirable to encourage Government aid to scientific institutions, you were referring principally to educational institutions?—Yes.

1215. With regard to your last illustration, about the importance of having a special training in a mine for those who are going to devote themselves to mining pursuits; you say that the young man who was sent by you to a coal mine in the north benefited very much by his experience there. Would a young man pursuing such a course as that, have an opportunity of learning the theory of mining; under those circumstances would it not rather be the practice that he would have brought before him, and in that case would not it be desirable that he should have some special course of educational training, with reference to mining, before going down into the mines himself?—But the instruction which he had in physics, mechanics, chemistry, mineralogy, geology, and perhaps one or two other branches of science, independent of the phenomena with which he had to deal, taught him the laws of which he had afterwards to learn the applications, and that was done by practice in the mines, where he saw the different systems of working coal mines. He would see in one mine perhaps the application of one system, and he then went to other mines so as to see a variety, and he also read books in which further information was given, but I am not at all prepared to say that some course of instruction connected with mining is not useful and desirable after the general scientific instruction had been given. I have no doubt that the special courses relating to mining which are given, are useful to those who hear them, and they might be given at any college to those who are going into mining, or they might be given in the mining districts, which has been done sometimes.

1216. Still, after the general scientific instruction do you think it desirable that any one who is going to embark in a mining career should have some special course of lectures with reference to the different systems pursued in different mines?—I believe they frequently do good, but the great thing is going into the mine, and actually working there. I believe that is the essential thing, but I believe that the other is also useful when done as it sometimes is.

1217. (*Mr. Samuelson.*) You have stated that you object to variations of teaching, having reference to the final application of the subjects taught. You referred I suppose in that only to the general scientific teaching which is common to all applications?—Quite so.

1218. But you would not object to a special teaching in reference to special applications where the general teaching had previously been pursued with sufficient completeness?—I believe that there is room for some useful work in special teaching between the scientific teaching itself and the practical study of the application. I believe there are many cases in which it is done with advantage, but where the special teaching takes to any degree the place of scientific teaching, I think it is a very great evil.

1219. You are anxious that the one should not be

substituted for the other, but you have no objection to the one being superadded to the other?—Quite so.

1220-1. In illustration of that, you stated that you thought that instruction in the methods of mining might be advantageous; would you not make the same reply in reference to applications of chemistry to the arts?—Courses of lectures on applied chemistry have been given and are still given, but the applications of chemistry to manufactures are so exceedingly various that I think if any young man were going to work at applied chemistry it would be an unprofitable employment of time to go through a general course of chemical technology. I think that what they ought to do after they have studied their science well, is to work in a laboratory at some particular part of the testing of ores, iron for instance; but I think that a course of lectures can hardly be given to them upon a particular part of chemical technology. I think it is not a profitable employment of their time to go through the whole course of chemical technology; they had much better go into their works and learn from them.

1222. In speaking of a laboratory, do you mean the laboratory in the works, or the laboratory in the school?—It might be the one or the other. In many cases I believe it is perhaps best done in the works. In many works there are laboratories fitted up for the purpose of carrying out accurately and well the determinations relating to the particular operations of the factory, and where such laboratories exist I think it would be best to use them; but in other cases let the students perform similar operations in the laboratories attached to the college. It is best to do it in the works, because then he sees, from a commercial point of view, the particular operations which he has to learn.

1223. Taking the instance which you have given of laboratory practice at works in reference to metallurgy, is it not the case that in many of those laboratories the modes of analysis are not quite up to the level of the best practice of the day?—Yes, I daresay that is the case.

1224. In such cases would it not be preferable that there should be the means of acquiring instruction in schools in the best practice of the day?—Yes.

1225. In speaking of the continental practice, I understood your objection to be rather to the attempt to introduce imitative factories, than to the study of application in the laboratory?—The profession and pretension to imitate practice I think is a positive evil, but I think that the putting forward in the prominent way in which it is done in some continental schools, the teaching of applications, is also an evil. I think the great business of a school is that the pupils should work at the theories for their own sake whilst they are there, and that afterwards in the works they should study the practice. I think they must change their point of view, and all the attempts to combine the two on the models which we have, I am convinced are wrong.

1226. Is it not the case that in the works a student is liable to learn bad practice as well as good?—Quite so; but he is not so liable in the works as in the school. Of course there are bad works and good works, but the bad works, by a process of natural selection, come to an end; they do not pay, I suppose; but there is a better chance for their practice in an average works than even in the best schools.

1227. Supposing for instance that the application of that practice should be more advanced in one country than in another; in that case would it not be desirable that the pupil should have an opportunity of learning the more perfect practice, at any rate in its theory, in schools?—If the practice were more perfect in one country than in another, I should send him there to learn practice, but the theory could be imparted to him before he went there for practical applications.

1228. And that was in fact the course which was pursued for a long time by continental nations, that



they sent their young men over to learn practice in this country?—That was so I understand.

1229. You spoke of placing the teachers of science in the most favourable position. Would you develop your views as to what would be the best means of placing teachers in such a position?—I could give some general suggestions. I think they ought to be free to devote all their best energies to the business of teaching and research, and I think that for that purpose there ought to be some little security for their income. If the teachers were, as frequently happens, solely dependent on fees, I think that that is undesirable. On the other hand I think they ought not to be independent of the fees. The French system of giving an endowment as the sole support is, I think, undesirable. It takes from the professors a sufficient inducement for exertion, and I should not recommend that system; but some small salary which would not satisfy their reasonable requirements or their ambition, ought, I think, to be given to everybody concerned. You ought to render the position such that it might be looked forward to by a young man as a reasonable career to devote himself to. At present, it is on prudential grounds not considered so usually, and I think that is wrong. Then I think that professors ought to have such aid in the way of apparatus and assistants as is needed to do their work efficiently and well. In many cases they suffer from the want of that, and they cannot really work at their science so as to produce upon their students the effect which they ought to produce. They are not in favourable conditions to do their own work for want of aid.

1230. From what sources would you provide those salaries and this apparatus?—As to what would be right in principle, I do not know. I have at times thought it might be undesirable that the State should interfere at all, but I conceive that, wrongly or not, that is hardly an open question. I think the State has entered upon the question of directing to some extent the course of scientific education, therefore I look upon that not as an open question. They have begun to do it, and that they should draw back and give up what they have commenced appears unlikely, in some respects undesirable, but anyhow exceedingly unlikely. At the same time I think to continue to deal with it in the present parted way, I mean by taking cognizance of only some facts of the case, is quite undesirable, and therefore I look to the State for such aid.

1231. Wherever need for assistance is clearly shown, and also that good work or tolerably good work is being done, then you would give aid from the State?—Yes, and that more would be done if aid were given; that consideration should come in.

1232. How could the State ascertain whether those conditions exist or are likely to be complied with?—I am not prepared to describe any one simple principle which by itself would be sufficient to lead to a sound decision in each individual case. I am inclined to think that the only safe mode of procedure would be to combine several such as I have mentioned some time ago. In some way or other I should like establishments that did useful work of various kinds to be all included; but I should also like an opportunity to be given for the opinions of competent persons regarding any one teacher or college. Supposing there were a council of education, they should have an opportunity of saying that they think a particular man, although not up perhaps to the material requirements, is in their opinion a man who ought to be placed in a proper position for doing such useful work. Take the case of Sir William Thomson: supposing he had no students, and that he were entirely devoted to research, as might be conceivable; I think he certainly ought to have the means of continuing any research which he should think desirable. It is of immense importance to the State not to interfere with him, and the Government might be told so. I take that as an example of a well-known man of great eminence.

1233. When you speak of a council of education, do

you mean a council of advisers to those who are publicly responsible for education?—That would be my idea, mere advisers. Do not give them the power of appointing anybody, but simply of collecting facts and expressing opinions. I should like the two functions to be separate.

1234. Would you think it desirable that the council should be a permanent body?—That is a point which I should feel a little hesitation about, but I should be rather inclined to renew it from time to time. I should be inclined to think that that might be the safer way of proceeding.

1235. But you would not think it right that the council should be chosen for the occasion?—No. I should like a council which would meet perhaps at stated times, and not merely a council for the purpose of particular questions which might arise.

1236. With regard to the first constitution of that council, would you leave the responsible minister quite at liberty to make his own choice, or would you also desire that advice should be taken from recognised bodies?—The suggestions which I have heard on the matter are of this kind, that it should be an elective body, elected by certain existing public bodies of recognised authority and usefulness; for instance the universities and some of the chief scientific societies, and possibly other bodies might be represented. I believe some analogy might be taken from the Medical Council, which is a body elected from various sources, though I do not know the particulars of its constitution. I am not prepared to submit a complete scheme of particulars. I have only got so far as to think that it would be desirable to have some such body elected as far as possible from public bodies which have scientific and teaching functions, and who know the particulars of what is wanted in this matter, and would select the individual members.

1237. Then are you of opinion that that council should be a general council for education, or would you have a special council for science, and another for literature?—No, I would not separate them in that way. I do not think one could do that well.

1238. You would wish one body to advise on all questions relating to education?—I should be inclined to recommend that certainly.

1239. You spoke of the Government not giving favour to one theory or another of science; will you kindly explain what you meant by that?—I conceive that if the Government were to aid one school by giving funds to aid their work, and if they were also to aid one school by preferring students who came from it for public appointments, and if the professors at that one school happened in their respective subjects to adopt theories different from those adopted by the professors in other schools, the Government would by that action favour the theories of those professors without having perhaps heard the theories named. The effect of that action would be to give them official patronage in fact, especially if the professors in such a school had to do with public examinations in which their theories would naturally come into account. That would influence teaching a good deal.

1240. Then, in point of fact, do you think that the progress of science has been suffering from such a state of things?—That would be a very strong statement. The present state of things, I look upon chiefly as the basis of something more, and I have been desirous to separate from amongst what exists, things which it would be desirable to develop, from things which are dangerous. I think that the present system if developed in a manner which appears consistent with the present practice, would lead to very great evils indeed to science; it would be specially opposed to the healthy development of science. I think the first thing of all is that science should be perfectly free in its development.

1241. Still you would recognise existing Government institutions as not to be destroyed, but rather to be developed?—I have gone very little beyond the consideration of general principles. The application to particulars would of course come when one was

Dr.  
A. Williamson,  
F.R.S.  
24 June 1870.



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24 June 1870.

quite clear with regard to the principles, and I do not think it likely that the Government would be inclined to draw back in what it has done, even though it has been done silently. Therefore I should prefer seeing how what exists could be most advantageously utilized. I would look in that direction, because really there is room for an immense amount of work, and for more work than can be done.

1242. You spoke I think of the large laboratory which is being erected by the Government?—I do not know it of my own knowledge. There are reports abroad of that kind.

1243. Supposing such a laboratory to be in course of erection, which I believe it is, and you were called upon to advise the Government what to do with it when it is completed, are you at all prepared to make any recommendations upon the subject?—I should not make any recommendations without learning a great deal more about it than I know at present, certainly, but my recommendations would finally be based upon a knowledge of what was contemplated in other departments of science, and upon the question of high education generally. A thing might be absolutely undesirable if it stood alone, a specially favoured school of the Government, and it might be as part of a larger system perhaps quite appropriate. I should only venture to form any opinion after learning a great deal more than I know now.

1244. Assuming such a laboratory to be completed, would you think it desirable that the purposes to which it should be applied should be kept in reserve until some such council as that which you have spoken of had been created?—I should say that provisionally that might perhaps be the wisest thing to do, but I should perhaps hesitate in completing it, if its completion in any way prejudged the use to which it would have to be turned when it should be finished. The rooms might be turned to many purposes if not specially fitted up for any one of them beforehand.

1245. With reference to the aid which you think the Government should give to research, would you leave the council of education to judge of that also, or would you ascertain it in some other way?—I think there are some general practices which prevail in other countries which might with few exceptions be adopted with advantage here. I think that everyone of the higher teachers of science ought to be placed in a position favourable to working at original research. I do look upon that as the highest part of the duty of every teacher of physical science, to keep in the college the older students at the higher work. The influence of those students upon the youngsters is something incalculably important.

1246. You would like to see that done in every college?—The definition of the word college would be the only question, but in every chief school, every one that came up to an acknowledged standard of efficiency, it should be so.

1247. Without special regard to the qualifications of the persons who are to conduct that research?—That would be of course an evil which one would desire to avoid, that such aid should be given to persons unfitted to use it properly. Of course any system must have some defect in its working, but I should be desirous of avoiding that evil as much as possible. There is one thing which occurred to me in connexion with it which perhaps I might be permitted to mention, and that is leaving to the Government, supposing they gave such aid to colleges, the power of recalling the aid in particular cases in which they might have reason to believe that the aid was not usefully employed. Supposing that the various colleges remained as now in the hands of governors or trustees or bodies who govern them, and that the appointments to chairs were made as now by the present governing bodies of those colleges, I think it might be worth consideration whether application might be made to the Government in each particular case for the ordinary aids which a professor would need, and they should give it upon a statement of the evidence

of what he had done after he had been a year or two at his work, and the grounds upon which he was appointed, and they would be free to withdraw it after a certain number of years if evidence came before them that he was not using it for the purpose for which it was intended. I should think it very salutary and right that the minister should have the power of withdrawing State aid where there was evidence that it was not used properly, and it would be better for the recipients that they should know that they had it on good behaviour.

1248. That brings me back to my question, who is to be the judge of that evidence?—If there were an educational council, if they were to have the facts referred to them, if they were to submit to the minister an analysis of the facts, and a report of the kind which I have described some time ago, and to leave to him the responsibility of deciding, I think there would be no fear of injustice being done.

1249. Then, in fact, one of the attributes of that council would be to advise as to the grants for original research?—I should rather put it in the form of grants to chairs. I should not imagine that they should go into the question of particular researches, but that the aids which as a rule ought to be given to leading professors would be for purposes of research, and that the council would have an opportunity of giving an opinion.

1250. Then you would leave the special application to the governing bodies or the body of professors of colleges?—Yes, certainly, I would leave them perfectly free in details.

1251. But you stated that you thought the Government should ascertain whether such researches would be useful; how would you make that harmonize with the answer which you have given?—I was not aware of having said that. I did not propose that the Government should ascertain what researches were wanted. I think I must have been misunderstood. I did not intend to express any opinion of that kind. I think that as a rule all the higher teachers ought to be on conditions such as to be able to work at research, and that they ought to feel it their duty to do so, but they must be left to choose their particular researches. I should think it very undesirable to attempt to direct them in that respect; they ought to be in the particular department of science in which they work, the best judges of anybody as to what work they should do.

1252. Have you at all considered the question as to whether the existing official schools could be made more useful and how?—I should feel great hesitation in offering any opinion upon the subject. The general feelings which would guide me in dealing with the subject I have described, but the particulars of their application I do not know sufficiently to express an opinion. I should certainly wish that all that exist should be utilized in the most fair and effective manner possible, of course with due regard to all personal interests of a general kind.

1253. Even if there should be some risk of the competition of those institutions with the independent ones being somewhat onerous to the latter?—At present the competition is on an unequal footing. The Government schools have special aids, and yet the colleges without such aid hold their own against it, that is the present state of things.

1254. Do you think it possible to avoid that where Government institutions exist?—No, the particular case which I allude to is an exceptional one, that Government only acknowledges and aids certain schools and does not acknowledge and aid others. I think that is unadvisable, I think that in its action in relation to the higher scientific education, the Government should distribute aid where it would be most useful, and should simply look to the existing usefulness and the chance of further usefulness.

1255. Is it not the case that the very existence of Government institutions where the cost of the erection of buildings, and the payment of the teachers is borne by the State, must tend to weight the independent institutions somewhat in competition, even if aid



towards the payment of the salaries of the professors be given to other institutions?—I think that as a matter of fact the monies devoted to the construction of independent colleges should not be so much looked to. For instance, two great colleges in London were given, you may say, to the public, and were subscribed for by persons who are now in the position of governors, and you may say that they were donations to the public, but whether the moneys were raised in that way or from the taxes does not leave any abiding difference in the institutions as it strikes me. The chief thing I look at is the manner in which they do their respective work. The University College is as much public property as the School of Mines, it is in the hands of governors who are only justified in using it for certain educational purposes, it is quite public property.

1256. But, in point of fact, there can only be an approximation to fairness as to competition between different institutions of that kind, Government institutions and independent institutions?—If they are on an unequal footing I do not conceive that there would be equality in competition, certainly.

1257. But how would you establish equal competition between institutions in which the professors are paid by the Government, and those in which they are only aided by the Government?—I should put them all on the same footing in those respects. Whatever might be considered best for their efficiency as public servants, I should apply to all.

1258. Would you withdraw the salaries from the professors in the existing Government institutions?—If it could be shown that they would be better without them I would withdraw them, but certainly I am not prepared to show any evidence of that kind.

1259. (*Dr. Miller.*) If you do not, you must endow the others to some extent, I presume?—Yes. I would judge the question from the point of view of public usefulness.

1260. (*Mr. Samuelson.*) Do you think that independent institutions would be likely to submit themselves to the same amount of public control as that which exists in the case of the Government institutions?—I do not know sufficient of the particulars of the working of Government institutions to be able to answer that question. I can only form a surmise, but I do not know any reason why institutions which are now perfectly independent, should not submit to reasonable and useful superintendence. I believe that it might be productive of good in their working to have inspectors coming and inspecting them. I do not know of anything in principle to prevent it. I do not think it is found in the Government schools to interfere with the just and proper independence of the gentlemen who do the work.

1261. (*Dr. Miller.*) By inspection, do you mean examinations?—That is one form of inspection, but I meant also that persons might possibly come into the lecture rooms now and then, and attend the lectures now and then. I do not know what form the Government inspection takes in the schools; I suppose it is chiefly examining.

1262. (*Mr. Samuelson.*) That would be one way, and probably the only way, of ascertaining whether the nation obtains a proper return for the assistance given?—Quite so. I think there ought to be some evidence that the money so contributed is usefully employed. I should not wish it to be given without that; I do not think it would be right.

1263. Do you think that that inspection is possible in the higher branches of education?—I quite believe that a system of inspection might be arranged which would not be disturbing at all to their usefulness, but would be rather advantageous.

1264. But such a system could only be established with the concurrence of scientific men generally; have you considered whether scientific men would be likely to approve of and submit to such a system?—Supposing your question to refer to the teachers of science in its higher branches, if it were put in the form of an alternative I conceive that the question would be

a very simple one. If you wanted aid, such and such are the conditions upon which alone you can have it. Supposing some declined the aid, I am not aware that that the system would be prevented working by that circumstance. It is probable that in some cases the alternative of refusing it might be adopted. I can imagine that, though I do not think it would be frequent.

1265. Those who refused, you think would have no right to complain that they received no assistance?—Unless the condition was a harsh one. We have not got before us any particular scheme, a scheme might be proposed which they would be bound to refuse.

1266. But you think that a scheme of inspection is possible, which the teachers in the higher branches might fairly be expected to accept?—I should think so.

1267. You spoke of college tests; are you of opinion that if any great weight were given to the system which you have described, under the name of college tests, it would be possible to avoid public suspicion of favouritism on the part of the professors or of those having charge of the teaching?—I am quite sure that in any system of examination there would be some failures. I do not judge it on the assumption that it could be perfect, but I think that the system might be so arranged as to be calculated to rectify itself. I should wish each teacher to be responsible for the statements which he makes, and if it appeared that a particular person made statements which were beyond the truth, I think that he would be by a very natural process eliminated, and his evidence would come to have very little weight with his colleagues. The great thing is publicity; people should have responsibility for what they say; and they would certainly learn that it was their interest as well as their duty to tell the truth. As a matter of fact the examiners are mainly teachers. All the examinations are conducted by persons who have been in the habit of teaching, so that the class of men is not a distinct class of men, and as teachers they know more about young men than they can learn by any examination.

1268. Are you aware whether it is the case or not, that on the continent the assistance of tutors in scientific teaching is more general than in England?—I should say that it is more developed in combination with the professorial function, for instance, in the *École Polytechnique* there are *répétiteurs* who occupy a place similar to that of tutors, and in the German universities, there is something which I may compare to the tutorial system, though it has a different name, the *privat-docenten*, junior professors. They have classes there who do work very much analogous to that which is commonly performed by tutors here, but they are not in such direct relation to the professors as I think it is desirable that they should be; they are rather competing with them individually than helping them.

1269. But the great subdivision of subjects which exists in the German universities to some extent replaces that, does not it?—I am not aware.

1270. But, owing to that sub-division, the number of pupils in any class will be smaller than in England, and the pupils will come more directly in contact with the professors?—Yes, that is the case in most German universities certainly, but in some it is not the case; in Berlin and in some of the large universities the classes are very great. In most of them it is as you say, the subdivision does produce that effect.

1271. You spoke of secret advice to the Government on questions of science, but is it not the case that so far as the Government is chiefly concerned at present with science, namely in its applications, Royal Commissions are generally appointed for the purpose of inquiry?—Royal Commissions are no doubt appointed.

1272. Take the case for instance of the inquiry into the pollution of rivers?—That was a case in which a great amount of work needed to be done. It was not exactly one of the cases which I have been contemplating. I conceive that the advising body

*Dr.*  
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24 June 1870.



Dr.  
A. Williamson,  
F.R.S.

24 June 1870.

might suggest persons to conduct such works, but it would not itself undertake it. Their recommendations ultimately would be preferred no doubt, supposing they made judicious recommendations.

1273. Then your suggestion was still rather in reference to a council, as distinguished from taking the advice of single persons?—Yes.

1274. (*Dr. Sharpey.*) I have before me the report of a Committee on Technical Education which was appointed in connection with the Society of Arts, and I believe your name is on that report; information was collected from a great many sources, was it not, on the question of the study of science with reference to its application to arts and manufactures?—Yes.

1275. I find it stated at one part that there was remarkable unanimity expressed by those whose opinions had been asked, "in recommending the study of pure science as the best ground work for all technical education. The special applications of each science may be learned in practice if a sound education in scientific principles has been received in early life." Do you concur in that?—Yes.

1276. I find it also said that the general dissemination of scientific knowledge is advantageous to workmen employed in the industrial arts; and in this report great stress is laid upon the teaching of science in schools, both in elementary schools for the humbler classes, and in what are called secondary schools, many of which have the benefit of endowments, and are frequented by pupils of the middle classes. I see it is recommended that certain subjects of science should be taught to a certain degree in the elementary schools, and in what are called the third grade of the secondary schools, for boys reaching perhaps 13 years of age, but that in the higher secondary schools, where they are presumed to remain longer, it is stated to be desirable to have science carried much higher, and the subjects of science are here mentioned. Have you taken into consideration the question of how teachers are to be obtained for those different duties?—I think that a plan might be developed such as that which I have briefly described a little while ago, and it appears to be the only promising general one for training teachers. I disbelieve in the so-called normal schools. I think that a normal school is one example of a fallacy of which there are many other examples, and that young men who are to be teachers, ought first to learn certain branches of science which are requisite for their teaching functions, and then they ought to have practical work in teaching under efficient teachers who can show them how to do it, and give them advice regarding the means of doing it. I think that every college ought to be as far as possible a normal school. I mean not in the sense of a school devoted only to that, but that the tutors who are wanted in the classes should be young men selected from amongst the best pupils, and who are to become teachers. The thing has been occurring spontaneously in my own classes for some years past, a good many teachers who have gone out from the college have been assistant tutors in my classes, and I very much wish, and have long wished to have the means of developing this practice into more of a system. I think that a normal school in which they would have lectures on pedagogy, which I believe is the accepted term, would really not teach them how to give instruction so well as the practical exercise in doing so which may be given them by efficient teachers.

1277. In view of the large number of such teachers that would be required throughout the country, and the different attainments that are required apart from the skill needed for imparting knowledge, do you think that the existing institutions would be quite adequate to meet the necessities of the case in the manner you mention?—I am quite sure that the existing institutions might do a very great deal, and I think if it were found by experience that they could not do enough, then would be the time to see what arrangement could be made for doing more, but I am quite convinced of this, that there do exist very great

resources for that purpose which are not utilized, and it would be a benefit to schools to combine that work with their ordinary work by the monitorial system. For instance, in a school for the teaching of boys, if the teacher of chemistry has a large class he must have some monitors under him, and that is a source of more advanced instruction to those boys, they get practical instruction in teaching.

1278. Do you believe that they could be trained practically in the various institutions of the country?—Yes.

1279. Supposing there were a normal school or a training school, it by no means follows that the instruction there should be confined to giving lectures and giving directions how to teach, do not you think that in those schools the teachers might be actually trained in the art of teaching, and might be engaged practically in the way that you mention?—I think that the most effectual training is of a practical kind, and that theory may accompany it. I think that an efficient teacher whom they aid, would naturally do what he is bound to do, that is to say, tell them the plan by which they must act, but he would certainly make them work better, if he wanted the work to be done efficiently, if he said, "You have charge of those boys" and you must teach them properly for your sake as "well as your own." That would be a practical system far more real and effective than any mere imitation of a teacher.

1280. Without going into the general question about tutorial as contrasted with professorial instruction, or as combined with it, might I ask whether in your own case, in which you employ this supplementary instruction very largely, it is not chiefly done by practical teaching, and not merely by question and answer from books, I mean in exercise classes?—In the exercise class of chemistry the work of the tutor consists in the first place in going over the notes of the students so as to see that all understand the subject of the lecture, or to supply any deficiencies which he may discover in that way. Then also it consists in giving them examples, and seeing that they are able to work out those examples properly, or explaining to them what is needed if they cannot do it; but that class is not practical in the sense of making experiments with apparatus; that is a subsequent class.

1281. Is the teaching you refer to intended chiefly for the younger or weaker members of the class, or does it apply generally?—I should say that it is not constituted of those especially. Of course some of the ablest do not require it; the élite of the class would be the least likely to require it, but still some amongst the best have used it.

1282. In that institution, what means have you of remunerating such tutors for this instruction, is it from the fees of the students?—In point of fact there are no adequate means; I speak now of University College.

1283. With regard to the aid which might be given by the State for original research in science, I think you suggested that professors and others who were engaged in teaching, and who were known to have been successful in scientific research, might receive aid, did you mean in particular cases or generally?—I should say as a rule all of them. It ought to be considered as part of their functions that they should be working at research, and they ought to be put in a condition favourable to it.

1284. With reference to particular inquiries undertaken by competent persons, are you aware that for about 21 years the Royal Society has administered a grant originally given by Government, and now voted annually by Parliament, of 1,000*l.* in aid of the prosecution of science, and that the council of the Royal Society associates with it 21 other gentlemen representing various branches of science, who receive applications for aid in the prosecution of special subjects in science, and consider the expediency of giving assistance, and recommend it to the council; and that that recommendation is generally followed; do you think that that system has worked well?—I may



say that I have had the honour of serving on that committee since I was last on the council, and I have always seen immense care bestowed by its members on the business. I can hardly conceive of any system that works upon the whole more satisfactorily than that one does, and when I have considered what outlet there was which one could hope for developing an activity of that kind, I have certainly fixed at once upon the Government grant fund, and I should wish it to be extended very greatly in proportion as it can be usefully employed. I do not see why they should not extend it to 10,000*l.* or 100,000*l.* if it could be applied in the same careful sort of way that it is now.

1285. Perhaps it might be taken as an example of the considerateness with which the Government grant is administered, that the Royal Society in one year repaid the Government the whole of the grant, because they had other sources from which to meet the immediate demands?—Yes.

1286. Having served upon that committee, you are aware, are you not, that the aid granted is in no way whatever restricted to Fellows of the Royal Society, or persons connected with them?—Quite so, the opposite is very much the case.

1287. It is frequently given, is it not, to young men who are engaged in scientific pursuits?—Yes.

1288. Are you aware whether the administration of that fund costs the State anything at all?—I think I may say I am aware that it costs the State nothing, it is done gratuitously by the committee.

1289. It does not even cost a postage stamp, I believe?—No, I suppose not.

1290. Do you think that that might be gradually extended?—Yes, certainly. I should look at an extension of it with great hope of usefulness, and it ought to be extended.

1291. Would you recommend that it should be extended by an increase made in the annual grant to be regularly voted, or that a representation should be made in a particular case where extra aid was required, and considered by the Treasury or some department of the State, and acted upon accordingly?—I should be rather inclined to prefer the latter process, that when a want is felt, when it is seen that more money might with advantage be distributed, then the council should make a representation to that effect. I should think that that would be the more satisfactory way perhaps.

1292. (*Professor Huxley.*) I gather from the evidence which you have given that you are altogether opposed to technical schools?—I think I had better say that I am.

1293. Would you put down all the medical schools?—No, because they are not technical schools in the sense in which I use the word. I mean by a technical school, one in which an imitation of practice is attempted. In the medical schools diseases are treated at the bedside, it is reality there, and not imitation.

1294. But at the medical schools, as a matter of fact, do the students perform operations in the hospital?—They become dressers, &c.

1295. The dressers do not perform operations do they?—I am not a medical man, therefore I had better say as little as possible about particulars, if you will allow me.

1296. But the reason why I ask the question is because the analogy appears to my mind to apply precisely, that is to say, that a medical school is to all intents and purposes a technical school. Whether it is a more or less perfect one is open to further discussion, but, as a matter of fact, the applications of science to practice are taught in a medical school, in precisely the same way as the applications of science to metallurgy are taught in a technical school, as I understand?—Then I have not been accustomed to use the word in that sense. I understand that the word "technical school" is intended to denote a school in which actual operations are not performed. We have not actually got a blast furnace in our School of Metallurgy, I believe, nor have we a

puddling furnace, nor do we actually make soda-ash as it is made in the works. And so with regard to other operations, it is quite exceptional that any one ordinary operation of any technical school would be performed as in practice in a factory. But, in an hospital the persons are there to be cured, and they have diseases, and the students are in a place where the thing is performed for its own sake; the operation of curing has to be performed for the sake of those poor people. That is what I do conceive to be a most important difference. It is exactly what I hold up for imitation. It is like sending them to mines to learn mining, or to a blast furnace to learn the making of iron.

1297. As a matter of fact, the operation of assaying is taught in technical schools practically and really, is it not?—As to the operation of assaying, I have no doubt that the general principles of it are taught quite correctly in technical schools, but I should not expect (I am speaking now only from what I understand), for instance, that the assaying of silver would be performed with the degree of perfection which would be attained by assayers, or which would be required by any practical assayer. I do not say that the distinguished men who teach it do not come somewhat near to that, but I do not conceive that they coincide in their operations with the practical assayers, who must have the work done perfectly.

1298. Do not you think that a student who has been put through the operations of assaying in a metallurgical laboratory would be in quite as favourable a position for actually practising assaying as a medical student who had only seen an operation performed would be with regard to the performance of that operation?—That operation of assaying is only a very small part of the work which a metallurgist would have to do; if he had learnt assaying in a laboratory he would be competent to do an act of assaying in a works.

1299. As a matter of fact, he would be in a much more favourable position, would he not, from having gone through the process, though not so completely, as in a regular assaying laboratory, than a medical student who has simply seen an operation for the stone, we will say, would be with regard to the performance of such an operation?—Anybody who has done a thing has learned more than one who has only seen it.

1300. With regard to all those higher operations all that a medical student can do is to see the thing done, he could not have an opportunity of doing it himself?—I think that you must know much more about hospitals than I do. I am hardly competent to speak of the particulars of the working of hospitals.

1301. Of course I have been familiar with medical schools myself, and I confess that it appears to me that the parallel between a medical school and a technical school is complete, except that perhaps on the whole a medical school is a more perfect technical school than can commonly be obtained; and that is why I put the question. Do you object to all regius professorships?—Regius professorships, I have no doubt, do a great deal of good, but I think that any system which may be formed must be built up upon the elements of the past and the present. Therefore I should not propose the abolition of the regius professorships which now exist, even if I thought them less desirable than others, which I am not prepared to say. I think upon the whole it is undesirable that any professor should be entirely independent of fees, and where regius professors are so, I think it might be desirable to give them an opportunity of increasing their incomes by getting fees.

1302. I think that in the majority of regius professorships the endowment is a very small one, and the main income is derived from fees; would you have no objection to them under those circumstances?—That I should think a very desirable arrangement.

1303. But does not the fact of this endowment give a particular regius professor an advantage over persons who are teaching privately?—Any endow-

Dr.  
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24 June 1870.



*Dr.*  
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24 June 1870.

ment would give a man an advantage over another who has not got it.

1304. Then in that case your argument would go, would it not, to abolish regius professorships?—No, it would rather go to equalisation, either by that or any other way, either levelling down or levelling up.

1305. You would probably go upon the principle of levelling up?—I have thought that upon principle it might be better if the State did not interfere at all, but I conceive that that is not possible. I cannot conceive how that could be done now. I believe that the thing would work itself out quite well if the State left it entirely alone; but that is not possible now I think.

1306. I gathered from what you were saying just now, that you think it proper that the State should give the same advantages to what we were calling private bodies just now, in the teaching of science, as it gives to public bodies; that is to say, that you would wish the State to make the same payments to professors in the one school as it does in the other, and also to adopt the system of inspection; that was your proposition, was it not?—Quite so.

1307. Supposing a so-called private body is paid by the State and inspected by the State, in what respect does it differ from a State school?—I conceive that it would in substance coincide with a State school then.

1308. Supposing that we had in London three or four such bodies as were proposed, paid by the State and their teaching inspected by the State, what would be the fate of some fresh private body setting up a school; it would have to contend immediately with unfair competition would it not?—That is a question certainly of great importance and some considerable difficulty, how new bodies could spring up. I do think it is desirable that it should be possible for new bodies to spring up, so that if the now existing bodies did not work on a right plan, it should be possible to get another to work on a better plan and to beat them. I should like that to happen. The question is one of some difficulty, how provision can be made to allow of that. I am inclined to think that some risk must be incurred by the founders. If persons would come together and subscribe a good large sum to start it (and if they had strong convictions they would do that), and if they would work it for a little while, and show that it really has got an important sphere of usefulness, I should say let the State treat them as the others.

1309. At present you consider that the existence of one State school does seriously interfere with private bodies; but would not the existence of six or seven operate still more crushingly?—No, because it would be upon a different principle. If it be acknowledged that the State shall aid all impartially, according to the evidence of usefulness, then a new school which was started under such a system would not continue to be devoid of State aid unless it was a failure, and useless, and undeserving of it; that is what I should wish.

1310. Any new school would have in the first place to exist for a certain time, would it not, before it could demonstrate its usefulness?—Yes, certainly.

1311. Would not your system render that impossible?—I should say not.

1312. It would have to come in competition with already practically endowed bodies?—Yes.

1313. It really would not live long enough, would it, to show its usefulness?—I think that institutions do come into existence in the face of others which had already existed long, and they do manage to thrive for a considerable time. I do not think that it would be an impossibility. I mean that if some system really different from any which existed were felt to be wanted, I conceive that persons would exert themselves sufficiently to tide it over those few years of infancy, and I should not propose that the Government should aid it until it had given some amount of evidence of real

usefulness, and of supplying some real want. That is certainly a difficulty, I am quite aware.

1314. Do you object to the continental system, the German system for example, by which almost the whole of the teaching is done, either directly or indirectly, by the authority of the State or through the influence of the State?—I have been a good many years in Germany, but I do not know accurately enough of the particulars to be able to answer your question fully, but from what I do know I have reason to believe that what exists in Germany is something very much like what I should wish to see here, that is to say, corporations which did exist and did work without any aid from the State, have received aid, whilst being allowed to continue their own functions, and they have left to them a great deal of independence. Each one works upon a somewhat different system from the others, and the State aids them to a certain extent, so as to complete their usefulness.

1315. But as a matter of fact, in almost all the German universities, the professors are now paid by the Government, are they not?—I think they are selected by the senatus and appointed by the minister. The nomination by the senatus is a function somewhat analogous to what I was just now speaking of. The senatus give reasons for their selection, and the minister is free to act upon their recommendation or to over-ride it, but as a rule he does act upon it, with very few exceptions I think.

1316. Is it not the case, that the minister very commonly acts upon his own mere motion; and when he sees a distinguished man, applies to him to be the professor of such a science at such a place under his orders?—My own knowledge is mainly of the other kind, of the motion being from the body of the university. The members of each university have been in the cases which I have happened to know of late, active agents, and have worked to get so and so for their university, they have moved to get him, and have tried to persuade the minister to give him a little more salary. No doubt there may have been cases such as you have mentioned, although I do not remember them myself. The professors in the cases that I have known have been the actual movers.

1317. You spoke of the influence of particular views of examiners; doubtless that is an evil which is more or less inseparable from all systems of examinations?—Quite so. I think I mentioned, in relation to the suggestion which was made, that the college test might be an evil on account of its one sidedness, that similar evils are liable to occur in examination tests, and yet one has to deal with them.

1318. I presume that that would be met by either retaining two examiners for each subject, or by changing the examiners at intervals?—Yes. I think that the system of the London University is very good in that particular.

1319. You have had a great deal of experience in examinations, and I dare say you have often noticed that it is by no means the best man who has got the first place always, but on the other hand have you ever known a case where a thoroughly bad or inferior man has got a good place?—No, I do not remember a case of that sort certainly.

1320. Do not you think that the circumstance which sometimes acts as a drawback to the best men getting the best place, namely, anxiety and nervousness, is after all an evidence that the examination test is a sound one, because that amount of nervous mobility is, so far, an obstacle to a man's getting on and doing his work thoroughly well?—I think so. I think it ought to tell certainly. But what it encourages chiefly is readiness. A slow man may be really better in the long run for a particular purpose, and yet he would not show it in an examination. A slow, quiet sort of man may have great qualities, and yet he may pass a poor examination, though he would be sure not to fail.

1321. I presume that you never did know a man get honours in an examination, who was a stupid man,



or otherwise than a first class man?—I do not remember any such case certainly.

1322. I daresay you are aware that there are schools in this country at present, like the Home and Colonial schools, in which teaching is taught as an art by practice in classes. Do you think the same thing impossible in a normal school of science?—If the class existed independently of the pupil teachers, you might call it a normal school, but its chief activity would be of another kind. I should wish to superadd the function of training teachers to other schools, that is rather the idea which I have now, so as to keep them constantly employed at that work of teaching, to give them an opportunity of finding and training teachers.

1323. Referring for a moment to the question of the equity of State action in subsidising the teaching of science, you are doubtless aware that almost every medical school, at present, has a teacher of chemistry; do you think it would be proper for the State to subsidise equally all the teaching of chemistry in all the medical schools?—I should feel a little delicacy in speaking about that. I should conceive that it would be desirable to draw the line somewhere, and the principles by which the line would be drawn, when considering the real effect of the teaching of a gentleman, whose energies might be more profitably employed in some other work, is a difficult question, but I conceive that it is desirable to draw the line somewhere. There is certainly a great waste of energy.

1324. The reason of that waste of energy is very much, is it not, because the teaching at those small medical schools cannot pay the gentlemen who give instruction in them, and therefore they cannot give their whole attention to it?—Yes.

1325. Upon the principle upon which you have been advocating State support, is that not rather more a reason for helping them?—If it were required to come up to the standard of an efficient school of science; but that is perhaps the question, whether they would do so or not. If it were shown that they really did succeed in teaching science efficiently and could do more, that is just the point.

1326. If the State made up its mind to give this general aid to scientific teaching which you have been suggesting, would it not be placed in a very difficult position in deciding where to draw this line?—No doubt there would be difficulties in that respect, any demarcation must be of some difficulty.

1327. (*Dr. Sharpey.*) With regard to Professor Huxley's question as to the position in which new institutions would be placed with reference to Government institutions, do not you think that their case is not exactly the same as that of those which now exist, because the existing institutions were in existence before the Government institutions were created?—Yes, certainly.

1328. And their case therefore is peculiar; they were not established in the face of those Government institutions; they were established independently, and existed for some time independently, and the Government institutions were created after them, whereas in the case of a new institution, of course persons might be restrained from establishing it because of the existing state of things?—Precisely so; but on the other hand, they would be encouraged, because they would know that if they really attained a sufficient sphere of usefulness they would receive the necessary aid, there would be that encouragement.

1329. (*Professor Huxley.*) That is to say, if you can lift the crushing weight which is upon you we will help you by all means?—Yes; they should make arrangements so that they should be helped if they are really a useful body; the question is how to do it.

1330. (*Sir J. P. Kay-Shuttleworth.*) Will you allow me to remind you that in the early part of your evidence, you stated that science in this country was not yet so much appreciated for itself as you could wish, but rather by the great mass of the people appreciated by its money results, and that consequently the number of students in science was not yet very great excepting in professions which led to certain

monied results: I would ask you whether you know of any other source of income for men of science, in this country, than first, teaching science; secondly, the application of science to commercial and social objects; or, thirdly, that which would be the least paying of all, research?—In the second category, that of objects of social usefulness, I presume you would include legal evidence, which takes the attention of scientific men to some extent; certainly those are the two chief ones, and the fees from teaching and professional work of various kinds. I think research might be put down in the negative scale. It is a source of expense simply. I am not aware that it is productive of profit at all, it is simply an outlay.

1331. I gather likewise that you conceive that teaching is inadequately remunerated, and that in the present condition of appreciation of science there is not much hope that teaching will be much better remunerated unless the Government in some way interfere?—I think that the actual remuneration obtainable in the existing absence of system is not such as to encourage a young man, unless by accident, to devote himself to it as a career. It is generally by some accident that a young man takes to it in that way; but on the other hand, I think that a return in the form of money, that is, fees from pupils, may be expected to increase very considerably when the public are more aware of what importance it is to them to have science taught.

1332. However, there must be a great change in the public appreciation of the advantage of scientific instruction before that can occur?—Quite so.

1333. And I understand you to say, that if that difficulty as to the impartial distribution of funds to the several schools engaged in teaching science could be overcome, you have no objection to the interference of the Government to increase the emolument of the teachers?—No, I believe that the higher teaching of science is nowhere self-supporting. I believe that in no country is it self-supporting. The result of its being left to its own resources, is that the teachers are unable to do some important part of their highest work. That is really my serious objection to the present state of things.

1334. In fact that must be so, must it not, if there be not a demand from an inappreciative public for science teaching, and the Government do not interfere?—Yes, certainly.

1335. You have in the course of your evidence hinted at various modes of applying the aid of Government impartially to schools, as, for example, that a portion of the money should depend possibly upon attendance, a portion upon the success of the results attained in teaching, and a portion upon the services of the teacher in scientific research; have I rightly understood you in that?—I am not quite sure whether I have succeeded in expressing correctly what I meant by that. I should not suggest that such a sum as it was thought proper to give to a distinguished professor of physiology should be divided into three portions, one third on the ground of the number of his class, and the other two thirds for other qualifications. My notion was less specific than that; that such a sum as was considered reasonable and proper should be given for any one of the three, or for the combination of a sufficient amount of each ground of selection. I do not think that to apportion it to each one by itself, in that manner, would be quite convenient or practicable. In fact anything like payment by results in the sort of way that has been usual in elementary teaching, I should hardly look forward to as practicable or acceptable in any way. I do not think that independent professors would accept it in that sort of way, it would be utterly out of the question I think. They would rather not have anything, than be bothered by anything of the sort, it would be degrading to take it in that sort of way. If a man is qualified to do this high work, you should give him 200*l.* or 300*l.* a year, or such sum as may be considered proper in such a case, that is my idea.

1336. You have recommended that there should be

*Dr.*  
*A. Williamson,*  
*F.R.S.*

24 June 1870.



15.  
A. Williamson,  
F.R.S.  
—  
24 June 1870.

an endowment of chairs, but I understood you to say, that if such endowment were given to chairs, there should exist some body who should have power at its discretion to withdraw the endowment?—That is an idea which has occurred to me, that the State leaving the college independent in itself to a certain extent might superadd an endowment, and should have the power to withdraw it if they thought proper.

1337. Do you see your way under such a system, taking into account the number of influences which affect the Government, to an impartial distribution of the funds amongst the schools and to the several professorships?—I have no doubt that there would be difficulties in the working of any such plan; but I do not imagine that they would be of an insuperable nature. Of course some difficulties in the working would occur, we must expect it under any system, especially a new thing; but I think the principles are so simple that there would be no great difficulty in the main in getting that object attained; at all events in other countries I think that the result is upon the whole a great deal better, than in the absence of any such system here.

1338. I am not expressing myself a preference for any particular system. I am only desirous of eliciting an expression of your opinion; but supposing an impartial distribution to be attained, and any apprehensions of caprice on the part of the Government or special motives in the application to be removed, if special schools for mining or for naval architecture, or for any other object, were placed upon the same footing as other schools, would not the difficulties as to the existence of special schools be by so much diminished?—There is one objection which I have felt to official technical schools which I beg leave to mention in connexion with your question, and that is that whereas I should wish that the Government should acknowledge by its acts the importance of pure science, their establishment of technical schools in opposition to schools of science, does seem to constitute a recommendation to something else than the study of pure science, and to favour a popular prejudice, which gives us a deal of trouble, that there is a royal road to proficiency. It is this effect which, of course, was not the least contemplated, which is the most objectionable feature in the system, as it seems to me.

1339. Your attention has been called to the existence of special schools of science in schools of medicine; is not science in its application to the art of war taught in a similar way at Woolwich?—I believe that pure science has been there taught, and also, no doubt, some of its applications to the art of war; but as far as I have learned, what is done at Woolwich has been chiefly instruction of precisely the same kind as would be given in a school which was not in any degree connected with a warlike avocation; the greater part of their studies are pure science.

1340. But they are also given in a school in which the applications of pure science to the art of war are likewise taught?—Yes, those subjects are taught together there to some extent.

1341. The same motive probably existed for the creation, in certain parts of Austria and Germany, of schools of mines?—The most celebrated School of Mines, is that of Freiberg, which is in the centre of a mining district, where the training is the real handling of machinery, they are actually made to go through in the mines all the operations which the labourers and various officials have to perform, and that, of course, puts that particular school of mines upon a footing somewhat more like that which medical schools occupy, for they have actual patients, and have to treat them themselves or see them treated.

1342. There are also days in which they are taught many departments of theoretical science?—Quite so.

1343. Are you of opinion that there is no advantage in the connexion of the practical training, for example in the school at Freiberg, with the theoretic instruction?—My impression is that in this school at

Freiberg they would do much better to cut off the theoretical subjects and to have them taught at some place where the best conditions existed for teaching those theoretical subjects, and only to admit the young men on their giving evidence that they have studied them thoroughly; and whatever practical instruction you do give, you had much better have by itself. It is not easy to organize schools of science; those that exist are susceptible of improvement, and the resources in the way of teachers for instituting new ones are always insufficient. I consider that existing schools of science ought to be utilized to the utmost.

1344. (*Professor Huxley.*) Then your objection is not to technical schools absolutely, but only to technical schools which may be said to be imperfectly constructed. Previously, in answer to my question, I think your objection to technical schools was absolute, but I apprehend from what you have just said, that if a technical school could be constructed upon what you would call thoroughly sound principles, you would have no objection to it?—I do not believe in the reality of the want which is supposed to be supplied by technical schools; I mean for a school intermediate between a theoretical school and real actual practice.

1345. Do not you think that this school at Freiberg does any good?—Yes, I think there are exceptions to anything, and that school is a remarkable exception in this respect, that it is not a school which endeavours to give imitations of practice, as it is in the centre of a mining district, and the young men are actually made to work in the mines and quarries like labourers, in the different departments of the work, and I believe that that is the great reason for its success. It has been a great success, and that distinguishes it from ordinary technical schools.

1346. So that if a technical school, we will say for teaching metallurgy, could be provided with that thorough apparatus of laboratories and the like, the desired training might be effected there?—Yes, if the students were made to work with apparatus identical with that used in the best factories, and to work as efficiently as in those factories, but not if they merely saw imitations of practice.

1347. Then I apprehend that your objection to technical schools is to the imperfection of their organization at present, and not to the existence of such schools themselves?—They do not actually show the practice, only an imitation of practice.

1348. You would not object to a technical school, if its organization were complete?—I cannot conceive that in any school the operations would be performed as well as in the best practice.

1349. Are not medical schools cases in point?—No, it is not an imitation of disease, it is really disease, that is precisely the point.

1350. But are not those metallurgical operations which are carried on in the metallurgical laboratory real operations?—I think not real in a commercial sense, and I think that the difference is most vital.

1351. Is the one absolutely no introduction to the other?—That it has a certain relation to it I do not deny, but that it is the same thing I disclaim; it is only an imitation of it, more or less good.

1352. You do not think that the relation of it is so close to the practice, as seeing an operation of lithotomy is to doing the operation?—That comparison I should hardly venture to consider, because I do not know enough of the cases that you put.

1353. (*Sir J. Lubbock.*) I think I understood you to say that the course of instruction at Woolwich was mainly of a scientific character and not technical?—I ought not to say "is," I ought to say "was," perhaps. I do not know what is the state of things now.

1354. I presume that you would not include fortification as a branch of pure science?—No.

1355. Nor artillery?—No.

1356. Nor the military history?—No.

1357. Those are the three principal subjects that have been taught there; was there any branch of



pure science taught there excepting natural philosophy and chemistry?—Mathematics were taught, and I think mechanics.

1358. Do you know what the amount of marks allotted to them respectively was?—I do not.

1359. But fortification, artillery, and military history being three of the principal branches of instruction at Woolwich, you could hardly say that the instruction there was mainly scientific?—The proportion between the two classes of instruction I really do not know; but I happen to have known some professors of pure science there, and have heard more of them than of the others, but the proportion between their work and that of the other professors, I really do not know at all.

1360. (*Mr. Samuelson.*) Could you name any cases in which an imitation of practice is given in the technical schools in this country?—The most remarkable case perhaps is the case of agricultural colleges, which I think have died a natural and very proper death in the main, but what was done in them I think may be reasonably described as imitation; the farming, I hold, was not farming in any proper sense of the word; it was the way not to do it that they showed; they professed to imitate proper farming, but it was only an imitation.

1361. Would you say that it was imitation farming where 800 acres or thereabouts were profitably cultivated, as was the case with the Agricultural College at Cirencester?—The Agricultural College at Cirencester, you are probably aware, is no longer on the footing on which it was. They could not farm it profitably, or they would have done so, and they have now let it to a man who knows how to farm efficiently and for his own profit; and I may mention who that man is, he is a gentleman who was for some years in University College, who afterwards went to Mr. Hope, of Fenton Barnes, and some other great farmers, and that is the way he learned his farming; he is now their model farmer, and that is what they have done in place of their imperfect imitation of farming.

1362. Do you think it is seriously proposed at the present day to establish colleges in this country, in which an imitation of practice should be part of the course of instruction?—It is difficult to answer for other people. I think there does prevail amongst some enlightened gentlemen an idea that something of the kind which has been done abroad might be done here. I have some reason to think so. I do not think that all the persons who are interested in the matter are fully aware of what has been the position of those schools abroad. I believe that they have attributed to them in many cases a success which the persons who know them more closely do not.

1363. You think it is not generally known that in nearly all the polytechnic schools abroad those imitative laboratories are now being abandoned?—I do not suppose that it is generally known.

1364. (*Dr. Stokes.*) In order to make your views clear respecting the points on which you have been examined by Mr. Samuelson, do you think that original research and the teaching of science should be combined, and that the best post which a person combining them could occupy would be that of a teacher in some college or other establishment?—To say that there should be no investigators other than those placed in colleges is rather more than I would venture to do. I would not say that. I think that although as a general rule it appears to me clearly desirable to combine as far as possible the two functions, there must still remain exceptional cases, which ought to be met, of men who have a preponderance of genius for research alone, who might from some circumstances be disinclined to undertake teaching functions, and perhaps not suited to discharge them satisfactorily. I should not by any means contemplate an arrangement which would not allow for exceptional cases of that kind.

1365. Would you contemplate a person of that kind who was not connected with an educational establish-

ment working by his private means or being aided in any way by the State?—As far as he can work by his private means it is desirable to let him do so, but the aid which he needs I think ought to be supplied from the State in proportion as evidence could be given that it would be usefully employed; and nothing has occurred to me so promising in the way of supplying that want of which we were speaking just now as an extension of the Government grant fund.

1366. You are aware I presume that the Government grant is applied to defray the costs of instruments and chemicals and things of that sort, and not in any way to the personal expenses of those for whom it is granted, therefore it does not assist a man who wishes to devote himself to original research in any way to obtain a livelihood?—No.

1367. Would you consider it desirable that a man of that kind should receive State assistance in any such a manner as should enable him, supposing he were not a man of private means, to carry on researches?—I should certainly wish to find some means of doing it safely, but I do not know any such. I fear that if it were to be given without any definite test of work done, it would be very difficult; therefore I feel at present quite unable to recommend any scheme which would appear unobjectionable, although I feel the object to be very desirable.

1368. But you think that a scientific teacher may in one case have great aptitude for teaching, and in another great aptitude for original research?—Yes; there may be different proportions between the two qualities. I think it reasonable that if a man had not much taste for the one to stimulate him to develop it, if he was not inclined to work, I would apply the spur to make him work, or if he was not inclined to teach, I would give him a motive to induce him to do it.

1369. In fact, you conceive it desirable, do you not, that, in the case of a man who had a special aptitude for original research, and was connected with an educational establishment, the State should in some way aid him so as to enable him to devote himself more particularly to original research?—I should not only recommend that, but I should be inclined to recommend even more than that, that all leading teachers should be placed in such a position as to admit of their working at research; that it should be considered as really a part of their natural functions, and provision should be normally made to enable them to do it, and not treat it as an exceptional case.

1370. Then if I understand you rightly, you think that the most healthy state of things would be that in which teachers of science (speaking more particularly with regard to the higher teaching) in educational establishments should have a fair portion of their time at their own disposal for original research?—Certainly.

1371. And how in that case would you have the work of education carried out. I presume from what you said by teachers under them?—I think there would be differences in the particular form of the arrangements in different cases. A man might in the beginning of his career devote more time to the tutorial work than later, but he ought when his powers are fully practised, to have chiefly the more difficult and the higher part of the teaching work, and leisure to work a good part of the year at original research, as a part of his teaching activity, and as an example to the students to show them how to do that most important kind of work.

1372. Do you conceive that the teachers working under him should be men who were paid for that work, or merely a superior class of students, who taught others as the best means of teaching themselves?—I think that the two might to a considerable extent coincide: they might get money for it, and yet be improving themselves, and that has really in cases with which I have had to do usually occurred, that men who have looked forward to improve themselves for a teaching career, have done so by getting humbler teaching work of that kind, and then better

*Dr.  
A. Williamson,  
F.R.S.*

24 June 1870.



Dr.  
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F.R.S.

24 June 1870.

teaching work, and so have risen gradually in that sort of way in the college. Then fellowships might probably be devoted to some such purpose in the older universities, if some duty of teaching were attached to the tenure of those incomes. It might be a very salutary and useful thing that they were not merely to live and enjoy the money, but that is a matter that you will know much more about than I do.

1373. Have you thought of any feasible mode of testing results in the case of original work, so as to distinguish those who do really work from those who do not?—I do not think that that could be done. I do not know any measure which one could apply in a direct manner to that. I can hardly imagine it to be done. Some of the best things might not be appreciated for a long time.

1374. To turn to another subject, you said that there was a defect in testing solely by examination, arising from this, that it gives an undue weight to mere readiness of production. Have you ever considered how far that defect might be remedied by shortening considerably the number of questions proposed, or lengthening the time for answering them?—In the examinations which I have conducted, I have usually felt it desirable to supply as much as the best student would be able to do during the time, so that I have not tested that question thoroughly. That seems a promising direction in which to look for a remedy. The only kind of remedy that I have thought of or attempted, has been practical examinations, I mean performing experimental work; that tests other qualities than mere readiness in stringing together words that have been learnt by heart. In the London University that is considerably done now, and with great advantage I think.

1375. Are you aware that in the University of Glasgow examination papers are given out for answering which the students are allowed what might be almost regarded as unlimited time; that is to say, ample time?—No, I was not aware of that.

1376. (Dr. Miller.) I think I understand that your objection to technical schools is not to technical schools in the abstract, but to technical schools as supported by the Government, is that so?—supposing that in any district, for example, a mining district, or in one of the large iron districts, it were considered expedient by the manufacturers themselves to establish a technical school, you would consider that that was itself evidence of the importance of such a thing?—I am not sure that I should. I think there might be manufacturers who would believe that something would be useful on erroneous grounds, they might fancy that they had got a solution which might prove to be a wrong solution, and an evil. I should not, judging in a general manner, consider that the fact of an opinion of that kind existing amongst a few manufacturers in a district proved that it was desirable that that course should be adopted. I should rather feel it desirable that they should be told what are the results of experience in this matter, and that suggestions should be given them for carrying out the object in the most efficient way by having a school of science, and then letting the students go to the practical application upon the work afterwards.

1377. If I understand your view of the value of the Mining School of Freiberg aright, it is that the advantage derived there is from the practice which the students get, and not from the principles which are taught them?—I think that its distinctive excellence is mainly practical; they actually see all the particulars of the operations together, and I think they would not get the good they do but for that, which no explanation could take the place of in the least.

1378. But supposing that those things are superintended by men of eminence and skill in science, does not that combination, in your judgment, materially affect the result, and would not the work they got at this school without superintending minds be of little value to the pupil?—I fancy that the good they get in mines is due to that fact, the mines are superintended

by efficient miners, and that the mine is being worked at a profit, and not merely superintended by scientific men on scientific principles, they are downright hard-headed miners, who do their work at a profit. That is the good which they get in mines, they learn some branches of science first and then the practical application of them.

1379. To turn to another point altogether, with regard to the following of science amongst men of science abroad, you are aware of course that the applications of science abroad do not form in general any very large source of emolument to the professors, for example, who are connected with the different universities; do you consider that the necessity under which a professor in this country is placed of supplementing his income by extraneous work is favourable to the advancement of science or otherwise?—I think that for the teaching of science it is very desirable that they should be free from such a necessity. I do look upon it as exceedingly important that they should not be under any such necessity, only if they wish for their own interest to follow this practice they should not be compelled to make up their income by the results of their consulting practice. I think it is felt to be an evil amongst scientific men that they are subject to that necessity.

1380. Do you see any way to the production in this country of a result analogous to that which is attained abroad?—I think that they ought to get a sufficient income to live in a modest way without the need of that, if they worked efficiently at science, as is the case abroad. A German or a French professor is sure to get sufficient money, if he gets on at his teaching work, to live as a gentleman like others; in England it is not so as a rule.

1381. Supposing that State aid were given to science professors, would it be necessary in any way to prevent them from devoting a portion of their time to such occupations?—You mean to make absence from such work a condition; that is a thing which might very reasonably be made a condition of State aid.

1382. In fact you consider that in this country science suffers from want of concentration on the part of those who follow it in many cases?—Certainly; at all events, that if State aid were given professors should not do it for pay, if they did it should be gratuitously. I would allow them to give opinions in certain cases without any fee, so that if their opinions were valuable they might have an opportunity of expressing them.

1383. Have you ever considered whether anything should be done with regard to retiring allowances to men who have served in position of trust, the same as is practised, for instance, now in the case of some of the Scotch chairs?—It seems to be natural that such small allowance as might be given, 200*l.* or 300*l.* a year, should remain as a retiring allowance to the occupiers of chairs. I think that that is almost an essential part of any complete scheme of the kind. There must be a provision for old age. I think there would be great evils from the want of such provision as it necessitates people remaining at work longer than they wish, or longer than they could well bear the fatigues of it.

1384. Have you considered at all on what principle such endowments should be granted to teachers of science, that is to say, who should be admitted and who should be excluded?—I have thought over the matter, but I am not prepared to propose any complete scheme, and to draw an absolute line between those who would be worthy recipients of such aid, and those who would not. I can see my way to some guiding principles which I think might in careful hands serve to draw the line empirically, but I think there must be at the last some empiricism in the final decision upon what cases would be proper and what not.

1385. Could you give the Commission an idea of the principles which would guide you?—I think that in colleges properly so-called, where the number of students attained a certain amount that you might name, and where there is some evidence that it is not mere



number, but some evidence upon examination tests that the work is efficiently conducted, the chief chairs of science might receive aid of the kinds described where they had not got sufficient means themselves. There are some colleges probably in the old universities that are far above any such requirements, and rich enough to do without State aid.

1386. I think I understood you to say that you do not see any difficulty in some application of the system of inspection; in what kind of way has it occurred to you, could such a system of inspection be worked?—An official record might be obtained of the number attending the classes of the teachers, and perhaps also a record of the work done by the students in the way of exercise, and materials of that kind might be supplied, but I have no objection to occasional examinations on the matter which is taught by the professors. The professor would have to give the inspector an outline of the subjects which he teaches, but I should not think it desirable that the inspector should prescribe to the teacher the subjects in which he ought to have taught; the inspector would merely examine in the programme of the professor. That might perhaps be done.

1387. Would those inspectors be appointed by the State as permanent examiners, or in what other way would you anticipate such an application of the system?—I have not thought of the particulars of inspection sufficiently to be able to suggest a scheme at all confidently. My feeling hardly goes beyond a general belief that it would be possible to form some such scheme, but I am not prepared with the particulars of such a scheme at present. It would be perhaps better that I should not make guesses at it.

1388. You gave a hint that some council of advice should be constituted for the Government in matters of science, would it not be very difficult in such a council to include properly the representatives of the different branches that would be required?—One of the processes for including representatives of the different branches of science which has been suggested, was this, that special scientific societies, such as the Linnæan, or the Chemical, and the Astronomical Societies, might be requested to send each of them a representative upon such council, to represent their branch of science. I think that such a plan as that might be worthy of consideration in connexion with it.

1389. In that case would not such body be selected for the nonce each time that the advice was required, would it not be a variable and not a permanent body?—The idea which occurred to myself and my friends was not that it should be constituted for each particular question, but that there should be a permanent body undergoing renovation according to some specific plan, the members going out after a certain tenure of office, for instance, and available for reference or advice on any questions relating to education or science which the Government might wish to have advice or information upon, as I think it would be inconvenient to attempt to constitute such a body each time that its advice was wanted. Little questions would not be brought before them, they would not think it worth while.

1390. In connexion with that, have you any idea of a minister of education?—I have always thought of it in connexion with the idea of a minister of education. I suppose that it is almost understood that there must be a minister of education before long, and he would receive advice or information from such a body as this, but in no case should a decision be come to by this body. I should make them a purely consultative body.

1391. Allusion has been made to the Government Grant Committee of the Royal Society, and the distribution of the funds placed at their disposal, and you have suggested that something of that kind might be the basis of the machinery for distributing grants of money for the aid of science. You are aware that that body only meets two or three times in the year, so that it consists of eminent men who may be very

willing to give their time occasionally, but if it became a serious frequent business, do not you think that there might be some difficulty in getting the work done by such a body as that?—I daresay that some remuneration would need to be given to some of those who work in that case; if a great call were made upon their time, it would hardly be possible to get a sufficient amount of work from them (supposing the fund increased very greatly indeed) without some remuneration; in fact, I should think it undesirable. You should pay people for the work they do, if it is worth paying for.

1392. With regard to the system of teaching, we have been informed that you have been in the practice of selecting tutors from amongst your pupils, have you any difficulty in meeting with gentlemen who have time at their disposal, who can afford in fact to do this thing easily?—To the extent to which I have worked that system I have scarcely ever found any difficulty. In fact, this summer there have been more applications for work on the part of young men than I have wanted.

1393. What class of young men are they that come forward for this purpose?—Young men who are studying scientific subjects preliminary to medical and other subjects. We have at University College a number of young men who do for some time work at several branches of science, before going at all into professional subjects; before going even to anatomy or physiology, they study chemistry, physics, and botany, for instance.

1394. Are those young men who are intending to make teaching a profession?—Several of them have been; others not. It is used by them merely for the sake of improving their knowledge of science and they are glad of it for that reason.

1395. Do you see your way to training a large body of men at very moderate emoluments, we will say for the inferior schools, primary schools, and others; do you see your way to bringing a body of men together, and training them scientifically for the purpose of science teaching in such schools by that method?—I do not think that in colleges where the higher scientific instruction is given there would be room for training a sufficient number of teachers for all the elementary schools. I could only contemplate teachers being trained in sufficient number if the secondary schools were to join in the work and were to have monitors or pupil teachers who would be trained in that kind of way.

1396. But they must be sent somewhere to be taught in science?—What they would do would be this: they would attend the principal lectures in chemistry, and then they would aid the teacher of chemistry in conducting a class next year, or correcting the exercises of others. That is the sort of thing which is already done in some schools, which I know. For instance, my friend, Mr. Barff, who teaches at the city middle class school, has introduced a system of that kind; he gets some of the better pupils, who have attended his instruction, to aid him in carrying on the class as a sort of monitors, and thereby aid the course of instruction, whilst they get practice in teaching in that way; of course they would need to get still more before they would be appointed as teachers; they would need to get similar practice in teaching in other subjects.

1397. Then there is no special pecuniary inducement held out in this way, or in the way in which you contemplate its being carried out in schools?—They have done it and do it without such a pecuniary inducement, but if they knew that they would thereby be able to get the place of schoolmaster, of course more of them would be anxious to do the work, but many of them do it now without any such inducement.

1398. (*Chairman.*) Would you make it a condition of giving Government aid to persons engaged in original research, that they should also engage in teaching to a certain extent?—I do not think that it would be desirable to make such a rule absolute. I think there are certainly cases, and there may be still

Dr.  
A. Williamson,  
F.R.S.

24 June 1870.



Dr.  
A. Williamson,  
F.R.S.  
24 June 1870.

more numerous cases of men who have done valuable work in research, and are able to do more, who ought to receive aid for that purpose, although they were not teachers.

1399. Do you think it desirable, speaking generally, that investigation and teaching should be combined in the same person?—Yes, in fact the exceptional cases are perhaps exceptions, more in form than in substance. It seldom happens that a man who makes important discoveries does not communicate them to the public, for instance, in lectures about the country, that is practically teaching.

1400. May I ask whether the income of the professors at University College, as professors, is solely derived from fees, or are there any salaries attached to their professorships?—There are two or three endowed chairs to the best of my recollection; there is one in comparative anatomy, which is a little aided in that way, and there is a little in the case of geology, but to a very small extent. There is 30*l.* or 40*l.* a year for the chair of geology.

The witness withdrew.

Adjourned to Tuesday next, 11 o'clock.

No. 6, Old Palace Yard, Westminster, Tuesday, 28th June 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D., Sec.  
R.S.

Professor JOSEPH HENRY examined.

Professor  
J. Henry.  
28 June 1870.

1403. (*Chairman.*) I believe you are the Secretary of the Smithsonian Institution in Washington?—I am.

1404. You have also previously been a professor in some college in the United States?—I was a professor for many years in the College of Princeton, in New Jersey.

1405. Have you any other appointment?—I am a member of the Lighthouse Board of the United States.

1406. Have you any appointment directly in connexion with instruction in science?—No.

1407. (*Dr. Miller.*) You are the Director of the Smithsonian Institution, and perhaps you will be kind enough to give the Commission a general idea of what the objects of that institution are?—I must thank the Commission for the honour they have done me in asking me to appear before them. The institution was founded by James Smithson, of England, a member of the Royal Society, who, after devoting his life to scientific pursuits, left his fortune to the United States to found, at Washington, an establishment, under the name of the Smithsonian Institution, for the increase and diffusion of knowledge among men. The original bequest was 541,000 dollars, which, by savings and by judicious investments, has been increased to 700,000 dollars. From the income of this sum, at six per cent. per annum, the institution is supported. There was at first a great diversity of opinion as to the manner in which the income should be applied to realize the design of the testator, as expressed in the brief, but comprehensive terms of the bequest. The distinction at that time between an institution for the advancement of knowledge, by the discovery of new truths, and one for the teaching of the knowledge already in existence, was not so generally recognized as it is at present, and Congress, after several years of delay, placed the expenditure of the income

1401. Is the same thing true with regard to other institutions of the same class as University College?—As far as I am aware of the state of things at King's College, I believe it is substantially the same. At Owens' college it is not so; there there are salaries to the professors. I think the professors receive mostly a salary of 300*l.* a year there. They did not spend their money on bricks and mortar, they thought that the chief thing for a college was to have professors, whereas we began with bricks and mortar.

1402. If salaries were provided by private endowments, or by private donations, do you think that the object which you have in view would be as well attained as by a Government grant?—Perhaps it would. I do not know any reason against it, but still, I think, it is right, on public grounds, that they should be considered as entitled to public aid. I think it is important that the Government should acknowledge the importance of their work nationally. I would rather not evade the difficulty.

under the care of a board of regents, and directed that they should make provision, by the erection of a building and otherwise, for the formation of a library, a museum, and a gallery art. It also gave 50 acres of unimproved ground, surrounding the site for the building, with indications that it should be planted with trees. Afterwards, however, though not without much opposition, it was concluded by the directors that those objects, although very important in themselves, were too local in their influence to come up to the liberal spirit of the bequest, which was intended not merely to benefit the citizens of Washington, nor even exclusively those of the United States, but mankind in general; and that the efforts of the directors should be to induce Congress to make a separate appropriation, from the public treasury, for the support of the objects just mentioned, and to devote, as far as possible, the income of the Smithsonian fund to the direct increase and diffusion of knowledge, by promoting original researches, and by distributing accounts of the results of these to every part of the civilized world. In this the directors have been in a great measure successful, though time and much persevering labour have been required to produce a change in the policy originally contemplated. A large portion of the income of the funds has been expended on the building. A library, principally consisting of nearly a full series of the proceedings and transactions of the existing learned societies of the world, has been accumulated, the expense of the care of which has absorbed another portion of the income; a museum has been collected, consisting principally of specimens to illustrate the natural history and ethnology of America, and also a collection of engravings and plaster casts to meet the original requirements of Congress as to a gallery of art; but experience has abundantly proved that any one of the specified objects, if properly sustained, would soon absorb all the income of the



bequest, and vindicated the policy of transferring the support of them to other funds. In accordance with this, Congress was first induced to take charge of the grounds and take the steps necessary for their improvement. It next took charge of the books which had been collected, and incorporated them with the national library, giving the institution and its collaborators the free use of the books of both collections. By this transfer the institution is saved in the expense of binding, cataloguing, and attendance, nearly 10,000 dollars annually, while it has the same use of its books as before the arrangement was made. Again, the agricultural department has taken charge of the plants of the institution, and the osteological specimens have been transferred to the Army Medical Museum. Furthermore, a wealthy citizen of Washington has made a large appropriation of money to establish and support a gallery of art, and it is proposed to transfer to this the articles which the institution has accumulated in the line of art. The object of this policy is to establish at Washington a collection of objects of nature and art, without trenching on the Smithsonian fund, which shall be worthy the capital of the nation. As a step towards this desirable end, Congress, at its present session, has appropriated 10,000 dollars towards the support of the museum, under the care of the institution, and also 10,000 dollars for the commencement of the fitting up of the upper storey of the Smithsonian building for the better display of the collections. The 10,000 dollars for the care of the museum will for the present, be an annual appropriation.

In regard to the increasing of knowledge by means of original research, it should be observed that the will makes no distinction as to any kind of knowledge, and here all branches are entitled to a share of attention, that is, all branches which can be said to be capable of definite increase; but these are proverbially scientific branches, and therefore the appropriations from the income of the bequest have thus far been devoted to the advancement of scientific subjects. The plan adopted for the application of the income of the bequest to what has been denominated the active operations, in contradistinction to the plan of the museum, library, &c., consists principally in assisting men of science in their labours, in instituting various series of observations or experiments and explorations; in publishing the results of these; and in distributing copies to all the principal libraries of the world. Whenever a man is found that is capable of adding to the sum of human knowledge, he is assisted, it may be, with instruments, books, specimens, &c.; or, if he is in the line of mathematics, in its application to physics or astronomy, in which arithmetical calculations are required, an appropriation is made for defraying the expenses of these. The institution also makes large collections of specimens in all branches of natural history, not merely to supply the museum under its care, but for distribution to advance this branch of knowledge; wherever anyone is engaged in a special line of investigation and requires specimens to aid him, the institution undertakes to supply them, and the only return asked is that full credit be given to the name of Smithsonian for the assistance afforded. The institution has established a series of magnetic observations and a system of meteorology, the latter of which has now been in operation for 20 years. It includes observations on the temperature, the pressure, and the moisture of the air, the winds, storms, and rainfall. The records of these observations have been placed in the hands of computers, and are now being reduced and discussed, with a view to publication. I have here two maps showing the result of all the observations on the rainfall which have been made in the United States. The institution has made many explorations in regard to the ethnology of America; has collected a large number of Indian vocabularies; and published grammars and dictionaries of several languages. The results of all these are published for distribution in a quarto form, denominated Smith-

sonian Contributions to Knowledge. In this way the institution has done a great deal of good, and I hold in my hand a list, numbering 1,568, of the foreign correspondents of the institution to which those memoirs are sent.

1408. About how much is the annual income of the institution?—It is now about 42,000 dollars.

1409. And is that distributed specially for the advancement of science, or is it told off to any particular branches of science?—The institution, up to the present time, has been obliged to devote a portion of its annual income to the museum and the construction and repair of the building. The remainder has been appropriated to researches, to explorations, to meteorology, and to the system of international exchanges, and to publications.

1410. The institution is under the government of a body of regents, is it not?—Yes.

1411. Will you explain how this body is appointed, and of whom, and how many members it consists of?—The body is appointed by Congress. There are three members of the House appointed for the time that they are elected to Congress, that is, two years; and three members of the Senate, also appointed during the time they are in the Senate, that is, for six years. Then there are six citizens at large, gentlemen of influence, and three *ex officio* members, the Vice-President of the United States, the Mayor of Washington, and the Chief Justice of the United States—the last of whom is the only person that is in for life; all the others are constantly changing, and they are not necessarily men of science.

1412. Are they re-eligible?—Yes, they are; and they are generally re-appointed from time to time as their term of office expires.

1413. How often does the body meet?—It meets once a year for one session, which continues at intervals for several weeks; and then the secretary makes a report of all that has been done during the year, and of the state of the funds, and recommends certain appropriations to be made for the next year. Those appropriations are generally made, and the institution goes on again to the end of the next year.

1414. What is the staff of the institution for working it?—The essential staff consists of the secretary, an assistant secretary, and a number of clerks, and labourers. The assistant secretary has charge of the collections of natural history, and the papers are referred to collaborators. We have lists of scientific men, and if a person applies for assistance, or if a paper is presented for publication, it is referred to a commission of men eminent in the line to which the paper refers. If the report is favourable their names are published, as you see on the reverse of the title of that paper before you, as vouchers for its importance; if the report is not favourable, the paper is returned to the author, and very frequently it undergoes a discussion between the examiners and the author. This discussion is carried on through the institution, and, as far as possible, the name of the author of the paper is kept concealed, and in all cases the names of those who examine it are not known.

1415. Is this Commission a standing body?—No.

1416. How is it appointed?—It is appointed by the secretary.

1417. The members are not necessarily residents in Washington?—No, they may reside in any part of the country, or even in any part of the world. Several papers have been referred to scientific men in London.

1418. I think we understand you to say that a large portion of the revenue of the institution is devoted to the furtherance of research?—Yes, that is so.

1419. Supposing that a person is desirous of being aided by the institution, how does he make his case known?—He applies to the institution, and if confidence can be placed in him, the appropriation is made. I may give you an example. There is a mathematician, now engaged in discussing the orbit of Uranus. Two or three years ago he made an investigation of the

Professor  
J. Henry.

28 June 1870.



Professor  
J. Henry.

28 June 1870.

orbit of Neptune, which was published by the institution, and has been adopted as the basis of the calculations with regard to that planet, I believe, by the computers of all the nautical almanacks. That paper involved a large amount of arithmetical computation, and those computations were paid for by the institution. Now, the same person is engaged on the planet Uranus, one of his objects being to determine whether or not the perturbations of that planet can be accounted for by the action of the planet Neptune, with a view of ascertaining whether there are outstanding disturbances which would indicate another planet still beyond. This investigation also requires arithmetical computations, which will also be paid for by the institution.

1420. The applications are made by the individuals to the secretary; does it rest very much with the secretary to decide upon granting them?—Yes, but he only decides after consulting with the collaborators of the institution, and he must have a general knowledge of science and be imbued with its spirit.

1421. Do you find that you can expend year by year that sum which is placed at your disposal in such a way as to give you satisfaction?—A great deal more could be expended if it were available, and it is for that object that we are endeavouring to be relieved of the expense of sustaining the museum and other objects. During the past year we have given 20,000 specimens of plants to the agricultural department on condition that a botanist, nominated by the institution, is appointed to take care of the specimens, so that they may be always accessible for scientific or educational purposes; in fact, that the institution is to have all the use of them that it would have if they were in its building. That saves the institution perhaps 3,000 dollars a year; and the transfer of the care of the books to the Congress, as I have already said, has saved the institution 10,000 dollars a year.

1422. Do you consider yourselves limited to American men of science?—Not entirely, but seeing that the bequest was given to the United States, and that there is a great want of it there, we prefer to give our countrymen the preference. But much is done in assisting the researches of foreign naturalists, by furnishing them with specimens, and in publishing such of their researches as may be connected with America: for example, the institution has published a work on the American Algae, by the late Dr. Harvey, of Dublin, and also several works on insects, by De Saussure, of Geneva, and a German naturalist.

The institution endeavours in all cases to occupy ground untenanted by other institutions, and whenever any other establishment will take up a line of research we immediately relinquish it and enter upon a new field: for example, a few years ago a report on forest trees was commenced, and collections of all the different specimens of the forest trees of the country for this purpose were made; and this having become very expensive, has now been turned over to the agricultural department, which will get an appropriation from Congress for it, and the work will be done, while the money of Smithson is saved for other purposes.

1423. What does the building itself represent?—Externally a Norman castle, and it has cost a very large sum. Unfortunately, architecture is frequently in antagonism with science, and, too often, when an architect gets his hand into the purse of an establishment, everything else must stand aside. Much trouble has resulted from this building; it has been a source of constant anxiety and expense, the cost having greatly exceeded the original estimate.

1424. What was the original object of the building?—It was intended to accommodate a library, a museum, and a gallery of art; but, inasmuch as the institution has turned over the library and the gallery of art to other establishments, the building will now be devoted entirely to the museum. The upper part of it was burnt, and it remains unfinished; and if Congress would accept the building as a gift, allowing one of the wings for the use of the institution, and

devoting the main portion to the museum, it would be a gain to the institution.

Independent of the building, the institution has a capital of 700,000 dollars now; so that the financial condition of it is very favourable. The friends of the institution are very sensitive with regard to its reputation, and are fully aware of the responsibility incurred by accepting the trust. The bequest came from England, and it is felt that the intelligence and integrity of the government of the United States are in some degree involved in the manner in which this bequest is administered, and there is a desire to administer it for the benefit of mankind, through the advance of science. Its importance, as an example, can scarcely be over-estimated: there are in the United States a great many men who have suddenly made wealth, and are desirous of distinguishing themselves, and they have in several cases founded schools and universities, but it has not yet become fashionable, although I think it will be in time, to found establishments for the advance of science. Professor Bache, with whose name the Commission are no doubt acquainted, left his small fortune of about 50,000 dollars to carry out the same idea as that indicated in the will of Smithson. He was one of the regents of the institution, and was so impressed with the importance of the advance of science that he left his property for making original research, and for publishing results; and no man can have a prouder monument, I think, than such an one as Smithson and Bache have erected for themselves. Every year the Smithsonian Institution publishes a volume of transactions entitled "Smithsonian Contributions to Knowledge," and these volumes are distributed in whole or in part to every first-class library on the face of the earth, carrying with them the name of the founder, and constantly reproducing it, not in one part only, but in every part of the world.

1425. Do you spend any large portion of your revenues in the collection of meteorological observations?—Perhaps 2,000 or 3,000 dollars a year, and we are endeavouring to get that placed under Government also.

1426. Are those observations founded by you, or in what way do you favour them?—The observations are voluntary. We furnish the observers with instruments in some cases. We did at first furnish them altogether with instruments, but this has been discontinued, except with respect to the rain gauges, and during the last year we have distributed about 500 of these.

There is one part of the operation which I have not sufficiently dwelt upon, and that is the system of international exchanges. In order to send the volumes of Smithson's Contributions over the world the institution has agents, an agent in this city, an agent in Paris, an agent in Leipsig, an agent in Amsterdam, and another in Norway; and every year the volumes of the institution are sent to these agents for distribution, and with them the transactions and proceedings of all the societies of the United States, and also of Canada, and of South America. For example, all the Canadian institutions send copies of their publications to the institution, and then the institution distributes them over the world, and receives in return for the several donors the proceedings and transactions of foreign societies. This part of the operation costs about 1,000*l.* sterling a year, but it is considered of great importance in the way of making science one in all countries. This is considered a very important part of the plan of operation. Not only are books distributed, but the institution has commenced the practice of distributing specimens of Natural History over the world and getting others in exchange. As an interesting fact in connexion with the system, I may mention that all the lines of steamers, the Cunard line of steamers, the German Lloyd's steamers, and the lines from San Francisco, all convey the Smithsonian packages free of cost; and also that they are admitted through all custom



houses without being opened, and free from all duties in all countries.

1427. (*Dr. Sharpey.*) Do you receive for the societies in America, for example, from the societies in London, and distribute those exchanges to the societies in America?—Yes, for all the societies. The great object is to facilitate in every possible way the promotion of science, and especially the fostering of original research, and enlarging the bounds of human thought. It is a matter of surprise that the idea is not more generally understood by statesmen and legislators, that modern civilisation depends upon science, including the knowledge of the forces of nature, and the modes in which they become the agents of man. Every discovery is connected with good. Even the human body cannot be properly understood without a knowledge of that of all other organised beings.

1428. (*Sir J. Lubbock.*) Is there in America any general inspection of primary schools corresponding to that which we have in this country?—In the different States there are primary schools and inspectors.

1429. Are they inspected by State inspectors?—Yes.

1430. But not by general inspectors?—The several States are considered as sovereign kingdoms, as it were. Each regulates its own code of instruction, and makes provision through its legislature for the support of schools.

1431. Do the States generally have any general inspection of those schools?—Most of the States have a school superintendent, as he is called, and he inspects the schools.

1432. Can you tell the Commission to what subjects the examination refers at those inspections?—They are reading, writing, arithmetic, geography, grammar; the ordinary elementary branches.

1433. Then it includes in fact some little elementary science?—No other, I think, than geography. The teachers may lecture on other subjects.

1434. But the inspection, you think, does not include that?—I think not in most cases. Then there are higher schools in the cities, and technical schools. Congress, a few years ago, devoted a certain number of lots of land from the public domain to found in each State an agricultural college, and this land was sold, and the proceeds applied to found and support those colleges.

1435. Are there any State scholarships in science which are open to the students in those schools?—No.

1436. Nor, I presume, any national scholarships?—No.

1437. Are there no national examinations of science in America corresponding to those which we have in connexion with the Science and Art Department in this country?—Not that I know of. This would all belong to the States.

1438. Do the States vote any sums for original scientific research?—Yes; almost every State has made an appropriation for geological investigation.

1439. Is that with reference to the geological survey, or with reference to independent geological research?—For geological survey generally; and the general government makes almost every year an appropriation for the same purpose.

1440. In what way are the expenses of the geological survey divided between the State governments and the general government of the United States?—The general government makes appropriations for the survey of the public domain, that is, of the land that belongs to the United States, which has not been yet formed into States.

1441. As soon as any Territory is formed into a State, the geological survey, if I understand you rightly, falls under the supervision of that State, and is not carried on by the general government?—That is so.

1442. Independently of the geological survey, are there any sums voted for original scientific research?

—No other than those connected with the geological survey, and the survey of the coast of the United States.

1443. Simply those that have direct practical utility?—Yes, and there is a small sum generally every year voted for experiments for lighthouses, and the several kinds of lighting material, improvements in lamps and lenses, fog signals, and so on; and I may also mention the appropriation of an annual sum for the maintenance of a national observatory which is under the direction of the Navy Department.

1444. Then there is no annual sum put aside by the general government of the United States, corresponding to the sum voted by the English House of Commons, and distributed by the Royal Society?—None; there is no fund of that kind.

1445. Could you favour the Commission with the whole amount of the sums spent in America, either by the general government or by the State governments, for scientific objects, for comparison with that which we spend in this country?—I should think, including that for the coast survey and other surveys, and also the observatory, 500,000 dollars a year. A resolution has just passed the one house appropriating 100,000 dollars to arctic exploration, but I am not certain that it will pass the other house. Just at present Congress is very stringent in its appropriations, on account of the finance of the country; but there is an increasing tendency to favour scientific investigations.

1446. Have you no materials with you from which you might give us any account of the sum voted, or the manner in which it is distributed?—No, but I might obtain it if the Commission wished to have it.

1447. Are there in America any professorships corresponding to the Regius professorships in the universities of this country, professorships which are supported by the general Government, and sums voted by the House of Commons?—In some of the States, the universities, for instance the University of Virginia, are supported by the State, but most of the colleges in the United States are supported by endowments which they have received from individuals of various sects, and they are generally sectarian, and the endowments have been raised by the church.

1448. Does the United States Government give any assistance to scientific societies in America, either by providing them with a house or in any other manner?—No, it does not. The great demand in the United States is for applied science, not theoretical science.

1449. (*Mr. Samuelson.*) I think you stated that a large grant of land was made by the Congress of the United States for the establishment of agricultural colleges. That grant of land was made, was it not, during the American troubles?—Yes, it was.

1450. That was a grant of land which was valued at between 30,000,000 and 40,000,000 dollars?—I do not know the exact value of the land. It was, however, very large.

1451. You stated that it was applied to the establishment of agricultural colleges, but was it not voted for the establishment of technical schools of various kinds?—I think it was for agricultural colleges.

1452. At any rate, hitherto it has been appropriated to agricultural colleges, whatever the intention of the vote may have been?—Yes, I think that is the case.

1453. You have stated that the United States Government is not in the habit of making large grants for the purposes of investigation, and that it does not give any great support, if any support, to the universities, but you stated also, did you not, that universities are founded and supported by some of the individual States?—Yes; but I should state that the general government does support two important schools, in both of which scientific education is predominant. These are the Military Academy at West Point, and the Naval Academy at Annapolis.

1454. Can you give the Commission any more detail upon the subject of the sustenance which is given to the colleges by the States; take for instance the State of Massachusetts?—I am not able to do so. I have

*Professor J. Henry.*

28 June 1870.



Professor  
J. Henry.

28 June 1870.

not paid special attention to the details. The general Government has within the last two years appointed a Commissioner of Education, whose duty it is to collect statistics on the subject and to prepare a report upon the education of the various States.

1455. But beyond that the scientific education is left in the hands of the States?—Yes.

1456. You have stated that in the primary schools of most of the States no instruction in science is given except in geography, but you have a system, have you not, of graded schools?—Yes, in certain States. I believe in Pennsylvania the pupils begin with the primary school, and they advance to a high school, and, I think, from that to the University of Pennsylvania.

1457. Could you state what amount of scientific instruction is given in the secondary schools of the different States?—I should think it was very small, but I do not know.

1458. And with respect to the universities, have you any knowledge of the amount and the quality of the scientific instruction which is given in them; take, for instance, Harvard College and the Cornell University?—Harvard University gives a very thorough course, and affords the means of instruction to resident graduates. It has lectures on physics, chemistry, and natural history; and there is a scientific school connected with Harvard University. The Cornell University is a new establishment, and is yet undeveloped.

1459. At the Harvard University is the attendance at the scientific courses obligatory, or is it voluntary on the part of the students?—It is obligatory. Perhaps there may be some courses that are not, but the pupils are obliged to be examined in chemistry and natural philosophy, and, I think, in natural history, in order to obtain degrees.

1460. Even those who wish to take a degree in arts would be examined in science?—Yes.

1461. (*Dr. Sharpey.*) Besides the geological surveys there are other scientific surveys, are there not, undertaken by the United States' Government, such as the coast survey?—Yes, that is a very large establishment and a very important one.

1462. And a very large amount of natural history knowledge is obtained in that way, is it not?—Yes, that which pertains to the sea. Many investigations with regard to the gulf stream have been made, and soundings are now in progress in it, under the direction of Professor Pierce, the superintendent of the survey.

1463. And also observations and collections in marine zoology?—Yes.

1464. Those are conducted of course by competent scientific men?—Yes.

1465. Who directs or advises with the Government in appointing those gentlemen?—The appointments are made really by the Director of the Survey, nominally by the Secretary of the Treasury; the Director of the Survey nominates the officer whom he considers a proper man, and he is appointed.

1466. I think you mentioned that the aid given by the Smithsonian Institution for the advancement of science and for scientific research, is to individuals, in the way of costly apparatus or appliances, expense of computation and the like, and assistance of various kinds?—Yes. The idea at first was to appoint professors and to support them, but the difficulty is to get men who can undertake original research; they are not obtained to order. Like poets, they must be born, not made.

1467. That is to say, men who spontaneously undertake researches would apply to you, and then you give them such assistance as you deem requisite to enable them to carry on their research?—Yes.

1468. There is no attempt then made to create an institution or institutions for the direct advancement of science, for instance, great laboratories, in which scientific men would be invited to undertake researches?—Before the fire we had a laboratory and a large collection of physical instruments open to any one.

1469. Did anyone take advantage of them?—Yes, many investigations were made, especially for the Government. Frequently the Government requires scientific information, and that has in many cases been obtained from investigations carried on in the Institution.

1470. Do the scientific societies in America receive either from the central Government or from the Governments of the different States, any aid towards the expense of their publications?—No, not generally; they do in certain cases where investigations have been made. There is a book just now published by the State, namely, "The Shells of Massachusetts." There has been a good deal done in that way in certain parts of the United States, and in Massachusetts especially.

1471. Of course, none know better than you that many of those publications which are illustrated in colours are very expensive?—Yes.

1472. And rather more so than some societies could undertake from their own resources?—Yes.

1473. In such a case does the Government aid them?—No, not generally.

1474. Would you approve of such aid?—Yes, very much; and I think that the Government will in time see the importance of such aid.

1475. The Smithsonian Institution reserves its funds for its own publications, does it not?—Principally the publishing of those things which cannot be published otherwise. If they can be published in the transactions of any of the societies, the Institution does not publish them.

1476. It does not, in short, take the work of other societies?—It does not; co-operation, and not monopoly, is the motto.

1477. Could you make any suggestion by which the interchange and intercommunication of scientific knowledge, by means of papers and in other ways, could be facilitated over the world still more?—I think that the plan now adopted by the Institution is a very good one.

1478. I mean that through the post offices facilities might be afforded?—Yes, that would be a more rapid means. Our exchanges are about twice a year.

1479. Is not once a year, or even twice a year, rather a long interval for the communication of scientific knowledge as science is now going on?—It is; and for all small papers we are now taking advantage of the new postal regulations between this country and America.

1480. (*Professor Huxley.*) I think I understood from your enumeration of the body of regents that the great scientific bodies of the States, like the American Academy and the Academy of Natural Science in Philadelphia, are not represented *ex officio*?—No.

1481. Do you think it would be any improvement if the scientific element, if I may so call it, were more largely represented in your board of regents?—That is a difficult question for me to answer. There might be some difference of opinion as to the amount of appropriation for different branches.

1482. Of course in your official connexion with the Smithsonian Institution it might be difficult for you to answer that question as you would wish?—Precisely so; the Institution has the co-operation of all those establishments, and in no case has there been any refusal on the part of their members to examine papers.

1483. I presume that you can hardly call the governing body of the Smithsonian Institution a scientific body?—No.

1484. Under those circumstances, I presume, that practically very considerable power is left in the hands of the secretary?—Yes.

1485. Is there any security that the secretary will always be a man of science?—I cannot say that there is, yet the institution having established a reputation while under such direction, it is hoped that he will be.

1486. There is no provision in Mr. Smithson's will, is there, that the secretary shall be a man of science?—The will is expressed in these few words: "I leave my property to the United States of



"America, to form an establishment under the name  
"of the Smithsonian Institution, for the increase and  
"diffusion of knowledge among men."

1487. So that if at some future time the regents should think fit to change the destination of the work which is done by the institution, and to turn all its machinery towards the increase of knowledge in the direction, we will say, of history, or philology, or literature, such change would come completely within the meaning of the words of Mr. Smithson's bequest?—Under the words "increase of knowledge," I do not think that literature could be included, though history and philology are subjects which fall within the present plan of operations.

1488. At present I understand the activity of the Smithsonian Institution is really directed almost exclusively towards scientific matters?—Yes, including ethnology. The institution is making great collections in everything relating to the ancient inhabitants of the country. During the last year many mounds have been opened, and their contents described and brought to the institution, and casts have been made of them for distribution. In languages, the institution has published a volume on the Uruba language of Africa, from the investigation of an American missionary. It has published a work upon the language of the Dakota Indians by another missionary, and it has collected 150 different Indian vocabularies, which are now in the hands of persons to be collaborated.

1489. Still it may be said that the predominant activity of the institution at present is in the direction of physical science?—Yes, and in the direction of natural history.

1490. Indeed it is mainly in the direction of natural science at present?—Yes.

1491. But still we may regard that as a sort of accident; that is to say, that hereafter the predominant activity of the institution might be directed towards philology, or to history, or to other branches of human knowledge, without in any way violating either the words or the spirit of the bequest?—To anything that is susceptible of a definite increase. A number of papers have been presented to the institution on philosophy, but the answer is, what are the evidences that they are true? and the rule adopted is to publish no unverified speculations. The author is allowed to give his hypotheses, because of course it is considered that all advance in science is by antecedent probabilities or antecedent hypotheses. An hypothesis which is of value must produce fruit, and when it so produces fruit it is then ready to be published by the institution.

1492. May I ask if such a work as Kant's Critique were offered to the Smithsonian Institution, would they publish it?—I think not.

1493. On what ground?—The indefiniteness of the subject.

1494. Supposing such a work as Mill's Logic were offered, would they publish it?—I think not.

1495. In fact, practically, philosophy is excluded?—Yes; not by any rule of the Institution, but by the nature of the subject.

1496. Supposing a work on philosophy were presented, it would come to you officially, as secretary, would it not?—Yes.

1497. Are you, as secretary, bound to lay it before the Board of Regents?—No, I lay it before a commission to examine.

1498. Who nominates that commission?—The secretary.

1499. That is to say, the commission is nominated *ad hoc* by the secretary?—Yes.

1500. I have no doubt that that hitherto has been a very beneficent arrangement, but practically the whole direction of the institution is in the hands of the secretary?—Yes.

1501. He is in point of fact absolute?—Yes; but his acts are subject to the control of the regents, and to the criticism of the public.

1502. Would the Smithsonian Institution think it

proper to make any grants for personal expenses, that is to say, suppose a man of great ability were applying to them for a grant in order to pursue some given research; if he were to say, I must live, and meanwhile may I use a certain portion of this grant to maintain me; would that be allowed by the rules of the Institution?—It would require considerable discretion; no definite rule has been adopted with regard to it. Where a person has gone on an expedition, the Institution has sometimes paid his expenses; and it has also sustained explorers. Before the purchase of Alaska, the institution sent up into that country a young man, who was there two years; he brought the Institution in relation with the servants of the North-west Company, and they have since furnished meteorological observations, ethnological specimens, and also specimens of all kinds in natural history, and the Institution in return has appropriated 500 or 600 dollars a year to purchase books for them, and such other articles as they cannot readily obtain. When Alaska was purchased or about to be purchased by the United States, the Secretary of State called on the Institution for information with regard to that region.

1503. I apprehend that if a physical philosopher made application to you for the means of pursuing some particular research, you would think it proper, supposing the application appeared to be of value, to supply him with funds for the purpose of setting up the apparatus which he required?—Yes.

1504. Do you say that you would make him a grant of 1,000 dollars for that purpose?—Yes, we might.

1505. But if a mathematician, whose apparatus cost him nothing, applied to you and said simply, I want to live for a year for the purpose of working out such and such a problem, you would not feel yourself at liberty to grant him a sum for his maintenance?—If the Institution had sufficient funds it would; but with the limited means that it has, it could not in justice to other researches.

1506. In answer to a previous question you spoke, did you not, of the appointment of quasi professors?—At the beginning of the Institution, at one time, that idea was entertained, but it was not carried out, the income not being sufficient.

1507. You are aware, I dare say, that in the Colleges of France there is a body of professors who are charged merely with the duty of advancing science, and giving courses of lectures of a most advanced character in their special departments?—Yes.

1508. Is there anything of that kind in the Smithsonian Institution?—No.

1509. Do you think it would be desirable, supposing the Institution had funds, that such should exist?—I think it would be very desirable that the Government should support such professors; and I think that in time the American Government will come to a proper appreciation of abstract science, and make appropriations for such lecturers as you mention in the city of Washington.

1510. What evidence do you require that the money which is given for investigation by the Smithsonian Institution is properly expended?—The main evidence is the fruit which is produced. The Institution is very cautious in not making an appropriation to any person who has not been found capable of advancing knowledge by original research.

1511. Supposing a grant made to a given person, A.; when his memoir is complete is that memoir published as a matter of course?—Yes, if it be found of value.

1512. Do the Commission of which you spoke just now in any way give a report upon the results of his investigations, or go into them at all?—Yes, they very frequently make suggestions, and say, this point is not well developed, or we think the author has made a mistake.

1513. Is the memoir referred to them before it is published?—Yes.

1514. So that it is possible that they might at last

Professor  
J. Henry.

28 June 1870.



Professor  
J. Henry.

29 June 1870.

reject altogether a memoir produced under those circumstances?—Yes; but then it comes back to the secretary, and he may not be satisfied with its rejection, and he may refer it to another commission, the names of the first commission not being published.

1515. The commission acts in the first place as a referee before the grant is made, and secondly as a referee after the work is produced?—Yes.

1516. Is it wholly in the discretion of the secretary to accept or to refuse the reports of the commission?—Yes, it has been so.

1517. Would you think it within the purpose of the Smithsonian Institution, supposing you had the funds, to make a grant for the purpose, we will say, of establishing such a thing as a physical cabinet or an observatory?—Yes. I think physical observations are of the greatest importance in the United States for observing the spontaneous phenomena of nature, and also for original experiment.

1518. I understood you to say just now that before the fire took place you had a very good physical cabinet in the building of the Smithsonian Institution?—Yes.

1519. Is there such a thing in the United States now as what is understood as a complete physical cabinet?—There are several connected with the science schools. There is a technological school in Boston which is well supplied with apparatus, and the scientific school at Harvard is well supplied, and also the one at New Haven, as well as that connected with Columbia College, New York.

1520. Was your cabinet open, under certain restrictions, to any person who wished to make investigations?—Yes, but not very much was done, because it was not in a very large place. My idea would be that if the funds were sufficient, and men could be found capable of advancing science, they should be consecrated to science, and be provided with the means of living above all care for physical wants, and supplied with all the implements necessary to investigation.

1521. What means would you adopt to prevent any arrangement of that kind from degeneration into a mere support for idle people, who would not make use of their opportunities; because such things do happen, even in the scientific world, that men who have abundant opportunities immediately begin to cease to use them?—Their tenure of office should depend upon the fruit that they produce.

1522. Do you think it would be desirable to connect with all such appointments the duty of teaching?—Yes, I think that a certain amount of teaching is an advantage to an investigator.

1523. Do you not think that that may be one of the best practical arrangements by which a man can be made to do his duty in such a position?—If he is required to teach a limited amount, and especially to teach the branches that he has been investigating himself; such a man always possesses an enthusiasm which he scarcely ever fails to impart to his pupils; they are proud of him, and the reputation of the institution is promoted.

1524. I think you are of opinion that it would be no drawback to the most profound investigator to be obliged to give a course of lectures if it were not too onerous?—Yes, I should think that in imparting information to others he would gain clearer conceptions himself; the mere repeating and giving an account of the investigations would be an advantage.

1525. Does the National Academy receive any support, either from the general Government or from the State in which it is lodged?—It was incorporated by Congress, and receives nothing from any State.

1526. Does it receive any support from Congress?—No, it has not as yet, except an appropriation of 6,000 dollars for the publication of its first volume of Transactions.

1527. It has no lodgment?—It has had no permanent lodgment; it meets in Washington now.

1528. It has no rooms there, I believe?—No,

although the Smithsonian Institution will most probably make provision for its meetings.

1529. Do the members of the National Academy receive any payment from the Government?—No.

1530. Does the Philadelphia Academy receive any support from the State of Pennsylvania?—No.

1531. How is the museum at Cambridge supported?—It has been supported by grants from the State of Massachusetts, and by the contributions of citizens.

1532. But not from Congress?—No.

1533. Does the entire burthen then fall upon the State of Massachusetts?—The State and individual subscribers. I believe the State has made a grant on condition that an equal amount should be subscribed by individuals.

1534. (*Mr. Samuelson.*) Is that for buildings?—Yes, for buildings, and for taking care of the specimens. Professor Agassiz, on his return from South America, had a very large collection of specimens, and they required a great quantity of alcohol to preserve them.

1535. (*Professor Huxley.*) You spoke incidentally of the Agricultural Department. Will you be kind enough to inform the Commission what that is?—The Government has established at Washington an Agricultural Department, the object of which is to collect seeds and plants from every part of the world, and to distribute them throughout the United States to agriculturists; to collect statistics; and to publish a report with regard to agriculture. It is doing very good service in collecting specimens of plants and seeds of all kinds, and distributing them in small parcels to agriculturists throughout the country.

1536. Are the agricultural colleges that you have mentioned under any control of the Agricultural Department?—No, they are entirely under the control of the State governments.

1537. The endowment of the agricultural colleges, however, was originally granted, was it not, by the central Government?—Yes.

1538. So that the central Government has endowed them, but has handed over the government of them to the States?—Yes.

1539. Do you conceive that the agricultural colleges are doing much good?—I think they are doing good in the way of teaching science, and I think they generally resolve themselves into ordinary schools in which science is predominant. In connexion with them there are farms, but I think that the pupils are not very desirous of gaining manual information or dexterity in the way of ploughing. Indeed, in America, the effect of education is to render people impatient in regard to labour. In Massachusetts, where education is most generally diffused, it is almost impossible to find an American who is willing to plough, or to do any low manual labour. The people of Massachusetts prefer higher employments: they make up, however, for this deficiency by the invention of labour-saving machines. There are more labour-saving machines invented in New England than in any other part of the world.

1540. Do you think that they get as much done by their labour-saving machines, and as well done, as they would by human labour?—More and better, I think. There is always required a certain amount of human labour, and this is accomplished by the Irish and the Germans.

1541. I judge, simply from hearsay, that there must be some scientific teaching going on in the State schools, because of the demand for elementary books in science in the State schools?—I think there is. I suppose the elementary books are on natural philosophy and chemistry, probably in the secondary schools. I may say that there is in the United States a large number of normal schools for teachers, and they have lectures on all subjects, and it is considered very important that teachers should be well taught.

1542. I think there is one direction in which the Government of the United States has done a good



deal for science which has not been mentioned to-day, and that is in the direction of publishing the results of voyages. A good deal of money has been expended, for example, has there not, upon Commodore Wilkes' voyage?—Yes, and also a large amount of money has been spent in publishing the surveys and explorations of the western parts of the United States relative to railways.

1543. (*Mr. Samuelson.*) Were the preliminary surveys for the Pacific railway conducted by the Government?—Yes.

1544. (*Dr. Sharpey.*) Were those publications distributed by the State or sold?—They were distributed to the members of Congress; each member had a certain number.

1545. (*Sir J. Kay. Shuttleworth.*) I understand that the building of the Smithsonian Institution is chiefly now used as a museum?—It is.

1546. And as no professors have been appointed, I apprehend that there are no laboratories there for chemical research, or research in experimental physics?—There are not just now on account of the fire, the fire destroyed that part of it.

1547. There are therefore no means in the building for experimental research?—Not at present; there are only a few remains of the apparatus.

1548. Would it fall within the legitimate objects of the bequest to establish laboratories and observatories, and other means of experimental research, in connexion with the Institution?—I think it would.

1549. And possibly, if professors, as you have previously hinted, were connected with those means of experimental research, they might make it likewise the centre of some teaching with the effect of keeping their own faculties in activity and vigour, and, as you have said, giving honour to the Institution?—Yes, that might be the case, certainly.

1550. Speaking generally of an institution of the class of the Smithsonian Institution, for the promotion and the advancement of knowledge and its diffusion, you would regard the existence of such means of experimental research on the part of professors in charge of classes as appropriate to such an object?—Yes, I should, their attention being mainly directed to original research.

1551. In fact, therefore, you see nothing in the character of an institution for the advancement and diffusion of knowledge which would be inconsistent with its becoming also a centre of instruction?—I do not, provided there were tutors to give minute instruction, while the teaching of the professors was restricted to certain limited courses of lectures. I have always looked upon the Royal Institution as a model establishment, doing honour to England, and producing an immense effect upon the world. More light has issued from that establishment in proportion to its means, than perhaps from any other on the face of the earth. It has had a series of great men connected with it, as Young, Davy, and Faraday, and it is still going on in the same direction. Then such an institution as I could desire should not, to any great extent, be devoted to things of a practical character. Abstract science, above all, requires fostering and support.

1552. I understand you to say that you would greatly distinguish between an institution whose primary object should be experimental research and whose secondary object should be teaching, and an institution whose object should be teaching, combined with technical instruction in any art or industry?—Yes, I think that the first is probably of far more importance than the second. By means of the second you will supply the world with engineers and persons well adapted to apply science to useful purposes and the arts, but among the multitude we occasionally meet with a man who has the peculiar mental capacity and endowment necessary for the advancement of original science, and he, in my opinion, should be consecrated to research. The discovery by him of a single principle, such as some of those by Faraday, may become the parent of a hundred inventions.

1553. A question has been already put to you by Professor Huxley as to the means which you could suggest to be adopted to prevent the professors of such an institution for combined research and instruction falling to sleep and becoming inactive; have you any suggestions to offer?—None, except the formation of a proper public opinion in regard to that matter, and it being definitely understood when the election was made, that if the professor does not fulfil his duty, if he goes to sleep and neglects the advancement of science, he must resign his position. Of course he may become incapacitated by disease or age, and if he has done good service he should then be provided for by the State.

1554. (*Dr. Sharpey.*) Are you aware that in German universities they appoint extra professors, and they also give permission to teach to what are called *privat-docenten*, who may give instruction upon the very same subjects for which the ordinary professor is appointed to teach, so that in that way he may be stimulated to exertion, or defects may be supplied?—I should think that a plan of that kind, under certain restrictions, might be advantageous.

1555. (*Marquis of Lansdowne.*) Would you say that there is at this time a great demand in the States for engineers and marine architects or surveyors?—Yes, more particularly for engineers.

1556. Is the supply at all equal to the demand; supposing, for instance, that a young engineer were to make his appearance in the States, would he have no difficulty at all in finding employment, or is the rate of supply sufficient?—He might have some difficulty at first.

1557. On the whole you think that the supply is sufficient?—No, I think the demand is increasing; the supply perhaps is coming up to it. A large number of our young men go to Germany to study practical science.

1558. Have you any means of knowing from what sources the supply is met; take, for instance, the number of engineers, which must be considerable by this time, and the number of surveyors, can you tell where they have acquired the knowledge necessary for their profession?—I think either abroad or many of them in the States at those scientific schools which have been established within the last few years; for instance, the school at Harvard, and at Yale College in New Haven, and at Columbia College in New York.

1559. If I were to ask you the same question as to practical chemists, is there a dearth of them, or is there a sufficient supply?—I do not hear of any young men that are unemployed in that line. There are a great many manufactories established in the United States, and if a young man is apt, I think there is no doubt that he will get employment.

1560. At those universities that you have enumerated just now, is there anything approaching to State grants, or regius chairs in aid, we will say, of practical chemistry, or such sciences as engineering, and so forth?—The school at Cambridge was established by an individual, and perhaps the university from its funds makes an appropriation. The school at Columbia College, New York, is entirely supported by the college, which is a very richly endowed institution. The New Haven school was also endowed by an individual, and, in common with the other schools which I have mentioned, receives fees from the pupils.

1561. (*Mr. Samuelson.*) Are the funds of Columbia College derived from private sources?—From original donations of land from the State of New York, which, in the progress of the extension of the city, has become very valuable.

1562. (*Marquis of Lansdowne.*) The endowments are not either from Congress or from the State in which the institution is situated?—In the case of Columbia College, the grant was from the State of New York; and in many other cases the States furnish aid to the Universities.

Professor  
J. Henry.

28 June 1870.



Professor  
J. Henry.

23 June 1870.

1563. I think you said that in the primary schools the cost of education depended upon the regulations of the individual State?—Yes, in all cases.

1564. Are you aware that elementary science enters into their course in any of the States, or in any of them more than the rest?—No, I am not familiar with the amount of teaching in the different States. I have not paid sufficient attention to that subject, but, as Professor Huxley remarks, the great sale of scientific books, and the higher instruction given to teachers would lead one to suppose that a good deal of scientific instruction is given, although it may not be necessarily required.

1565. I think you said that there was a government officer called the Commissioner of Education. I presume that there would be some record in his department as to the different kinds of education given in the different States?—Yes, I think by application to him when I return I might get the statistics, and I will forward the statement to this Commission if it is required.

1566. (*Chairman.*) Does Congress exercise any control over the application of the funds dispensed by the Smithsonian Institution?—No.

1567. The only connexion between Congress and the Institution is that a certain number of regents are appointed from the House of Representatives and the Senate?—But these regents are responsible to Congress for the conduct of the Institution.

1568. Are you in the habit of making any annual returns to Congress of the manner in which the funds have been applied?—Yes. An annual report is made, and that would form a pamphlet a little larger than this before me, and, in order to take advantage of the liberality of Congress, an appendix is added to this report, consisting of translations from foreign journals, of semi-popular information such as would be important to the teachers of the country, and to meteorological observers. About 15,000 of these reports are printed at the expense of Congress, and about 4,000 are given to the Institution for distribution amongst teachers and among its *collaborateurs*; and in that way there is a considerable diffusion of knowledge.

1569. Has it ever been under consideration whether Congress could properly make an additional appropriation in aid of the funds of the Institution?—Yes. When the funds of the Institution came to America, they were lent to one of the States, and that State failed to pay; but Mr. Walker, one of the secretaries of the Treasury, established a rule that all money coming into the Treasury of the United States on account of the land sold for that State should be retained until this debt was repaid by the State. The United States, however, after eight years, assumed the debt, and declared that the Smithsonian fund

The witness withdrew.

money is for ever in the Treasury of the United States.

1570. And there was no actual loss from it?—No, there was no actual loss to the Institution, and now it appears there will be no actual loss to the Government. The proposition has been that the Government should take the proceeds of this old debt, and appropriate it to the establishment of a museum, thus relieving the Institution entirely from the charge of the museum; and there is nothing to prevent Congress doing so.

1571. Are the annual applications in excess of the funds that you have at your command?—We could dispense a great deal more than we do, but in order to satisfy the regents it is necessary that we should save a little for contingencies, and show a favourable balance.

1572. You accumulate every year, do you not?—Yes, a little.

1573. (*Professor Huxley.*) You have doubtless heard that in this country the Government places 1,000*l.* every year at the disposal of the council of the Royal Society, and that the council of the Royal Society appoints a committee, consisting not only of its own members, but of representative men of science belonging to other scientific bodies, and that committee is called the Government Grant Committee. All applications for portions of the money granted by the Government are made to that committee, and they are practically decided upon by it. The committee consists entirely and purely of men of science. It is in fact a sort of scientific parliament on a small scale, containing the leading representatives of every scientific body in the country. May I ask whether you think that that is a better mode of administering funds in aid of science than through such a body of regents as you have in the Smithsonian Institution?—I should not like to say that it was better. On that point I would rather not decide. The Institution has been formed under peculiar circumstances, and it has so happened that the funds are in charge of men who are not scientific, and it must always be so; but they are now men who are in favour of science, and they trust to the secretary the management of the establishment. But I think that the appropriation of a sum of money expended in the way you mention is of vast importance, and I am only surprised, excuse my saying so, that a nation of the wealth and intelligence of Great Britain should appropriate so small a sum.

1574. You have doubtless heard that small as that sum is, it is not all expended?—No, I have not heard that. There are various fields of research in which 20 times that sum might be readily expended.

1575. (*Chairman.*) Are there any other points on which you would like to give the Commission any information?—I do not think I can give any of importance.

Professor FLEEMING JENKIN, F.R.S., examined.

1575. (*Chairman.*) I believe you are Professor of Civil Engineering in the University of Edinburgh?—I am.

1576. Did you also hold a similar appointment in University College previously?—I did.

1577. A part of your own education was acquired on the continent, was it not?—Part of it was. I was at the University of Genoa, and took a degree there. I also served the usual pupilage under Sir William Fairbairn as an engineer.

1578. You have therefore had the means of comparing the foreign and English modes of education for the engineering profession?—I think I have. On receiving my appointment in Edinburgh I visited a considerable number of the colleges abroad with the object of ascertaining what was done practically to educate engineers abroad, and to refresh my memory on the subject.

1579. You state that part of your education was

acquired on the continent; perhaps you will be so good as to tell us the whole course of your education?—I was at school in Edinburgh, subsequently in Frankfort-on-the-Maine, and subsequently in Paris. I went to the University of Genoa, and then I served my apprenticeship under Sir William Fairbairn. At 18 I entered Sir William Fairbairn's establishment.

1580. Can you give us a general view of the principal differences between the system on the continent and our own system?—The systems of educating engineers differ totally abroad from the English system. Young engineers are trained in special engineering colleges, but in England they are now nowhere so trained. What is called the apprenticeship, or, in late years, the pupilage system, has prevailed exclusively, and in choosing the pupils no discrimination whatever is exercised as to their fitness, so far as I am aware. All engineers do not agree upon that point. There has been, until lately,

Professor  
F. Jenkin,  
F.R.S.



no instruction in classes of a systematic kind for engineers in England. There is no apprenticeship, practically speaking, upon the continent, as far as I am acquainted. The education of young engineers is entirely acquired in special colleges.

1581. Is their theoretical knowledge much superior to that acquired by young English engineers?—It is; but if I were to engage a young man for work I would prefer engaging a young Englishman, a successful pupil upon the English system. I think it turns out a man more capable of doing work.

1582. Do you think that in a certain degree the combination of the two systems would be more perfect than either?—Yes, most assuredly. The ideal that I should propose to myself would be this: that men should go into their pupilage well prepared in the purely theoretical branches of knowledge—the mere mother sciences as I call them—mathematics, chemistry, and natural philosophy chiefly. Then that they should go through their pupilage, and towards the end of their pupilage that they should attend some courses, which might be called technical courses for want of a better name, the object of those courses being to show the pupil how his theoretical knowledge can be applied in certain instances to the practical demands with which he has become somewhat familiar by that time.

1583. Have any of our engineers been able to acquire great eminence without any theoretical knowledge, or with very slight theoretical knowledge?—They have been, but that will become more and more difficult. I think that in the future a man without theoretical knowledge will be at a considerable disadvantage; in the early days of a profession a man of sound common sense only will rise to the top, but the engineering profession is becoming more and more complex.

1584. But are there any branches of science which you consider as of paramount importance in the education of engineers?—Those I have already named. I am very decidedly opposed to the establishment of engineering colleges in substitution of the apprenticeship system. I think even as we stand that we turn out better men than are turned out abroad, even comparing our system with the German Polytechnic schools, which I think are as good a class of Polytechnic schools as we could possibly hope to have; indeed I admire them extremely; still I think that our young men are on the whole the better men; and although I have known many men who were at the Putney Engineers' College in England, and who have become fair engineers, I think that it would be a step back to establish those special schools. On the other hand, it is quite clear that our young engineers are very badly educated, and that we ought to do something for them if possible, and that should be done in some systematic manner, not trusting wholly to the common sense of each man. I have thought that I might perhaps illustrate what I should like to do better by a reference to telegraphy, which is of course a novel subject, than by reference to engineering, in which we have got into a rut or groove already.

1585. Will you be so good as to explain to the Commission your views upon the subject, and the course which you would like to see adopted?—I think that in telegraphy some action must be taken very shortly. The young men who are now being sent out to all the different foreign stations, and also those taken into the Government service, are sadly deficient in proper knowledge. It will be necessary to appoint new men of higher qualifications than the old, and some steps must be taken very shortly. Now there are two courses which one might follow, I think; you might create a special school of telegraphy, you might have an entrance examination of course and have separate technical classes, a class say of electricity dealing with those branches specially used for telegraphy, a class of chemistry on the same principle, and a class, say, for long submarine cables. A man could easily give 100 lectures upon that subject, and you might have a class of instruction

for land lines, you might have a class in connexion with transmitting and receiving instruments, which is a very large subject indeed, and you might have a class in mechanics and a mechanical workshop, in which the transmitting and receiving instruments should be made. In some such way as that you might create a real telegraphic college, appointing the best men you could to teach each of those different subjects. That would be a sort of imitation of the different branches of the foreign Polytechnic schools, but that is not the plan that I admire, or that I would adopt. I would do this: I would have an entrance examination in pure science simply, in chemistry, in mathematics, in natural philosophy, and in linear or mechanical drawing. Having selected young men of good abilities, who were prepared in that way, I would appoint them assistants or pupil assistants to the telegraph inspectors or superintendents throughout the country, supposing I am now dealing with the Government service only, and in inspecting the telegraph lines they would see the construction of the lines. I would send them by rotation, not two or three of them together, but one by one, to those men, then to the large stations as assistants to the clerk in charge of the station, and then into the actual workshops where the instruments are made. After about two years of that work, which would correspond with the pupilage of a civil engineer, I would require their attendance, say, for six months (I think that would be long enough), on two or three special courses; one, say, upon land telegraphy, and the other upon sea telegraphy, and at the end of that time I think I should have a well trained man, and a much better trained man than a man who had simply been at a college, and I think that that training could be given at very small expense. At the end of that time I would not necessarily give every man a Government appointment; I would not have a final competitive examination, but I would judge of the relative merits of the men by the reports of each master under whom they had served, in conjunction with their entrance examination, without any final examination.

1586. Could such a system as you recommend be established without the intervention of the Government in some shape?—For telegraphy not.

1587. But the entrance examination you would allow them to prepare for in any way they pleased?—Yes, in any way they pleased.

1588. Taking advantage of existing institutions?—They would take advantage of existing institutions, not but what the number of the existing institutions requires multiplication, that I grant.

1589. But, at present, a young engineer does not feel that he is called upon for his own interest to get a good preliminary theoretical education?—He does not. He is improving in that respect certainly, but it is not required, and where it is not required it will not be done. I mean that he can get an appointment, and obtain a livelihood without it.

1590. You would apply a system of the same kind to other branches, would you not?—Yes, for instance, in naval architecture I would do much the same thing. I would send a man as pupil to the different large Government establishments.

1591. There are no lectures at present, I imagine, in telegraphy?—I think none; and I think that they ought clearly to be instituted in several parts of the kingdom.

1592. (*Dr. Miller.*) Do you know that that is being done now at King's College?—I do not know that, but it should be so unquestionably.

1593. (*Chairman.*) The want of some instruction of that kind will shortly make itself felt, will it not?—I think it must; especially now that the patronage is in the hands of the Government, when men must be appointed, more or less, according to merit. I think that to attempt to examine a man in professional acquirements is a mistake. I do not think you can ascertain by examination whether a man is a good telegraphic engineer or a good civil engineer.

*Professor  
F. Jenkin,  
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28 June 1870.



Professor  
F. Jenkin,  
F.R.S.

28 June 1870.

1594. I think I understood you to say that the course of instruction at some of the foreign colleges is as good as it can possibly be, but still they practically do not turn out men as useful as some of those that are trained in our own country?—That is my opinion. I have executed work abroad as an engineer, and having had so large a portion of my education abroad, I do not think that I have strong British prejudices upon the subject, and yet I certainly would rather employ a young Englishman than either a German or a Frenchman.

1595. (*Professor Huxley.*) Is that for the moral qualities of the Englishman, or his intellectual ones; because both are very important, the one as much so as the other?—Both are important. It may be that it is the combination of the two which we get in the young Englishman.

1596. Is not the education of the hand and the eye important as well as that of the intellect?—Yes. A man who merely hears about work has no definite idea of what is meant by it. I find that in teaching my own pupils in Edinburgh, the young men who come to college before entering their pupilage, when I speak, for instance, of a connecting rod in lecturing on the elementary parts of a machine, they have no idea of it, and they cannot learn about it because they attach no definite idea to the thing at all. The men who learn are the men who have been brought in contact with the work, who have already felt their ignorance; and if after they have felt their ignorance they can get a chance of learning, they absorb knowledge with great rapidity.

1597. (*Mr. Samuelson.*) In speaking of the superior qualifications, as practical men, of the English over foreigners, I presume that you confine yourself to the question of civil engineering; you do not include metallurgy or chemistry?—I do not know anything about either of those subjects; I speak of mechanical and civil engineering. There is a tendency to stereotype their ideas. A man has learned a thing abroad; he knows it; he knows all that is to be known about that particular subject, and he is less willing to adopt changes and to invent changes. He wishes simply to work according to the principles which he has been taught.

1598. Is it not the case in many of the great engineering works which are now being executed on the continent, that the economy of materials has been carried to a very much greater extent than is the case in England?—That certainly has not been my experience. At Rouen, where I executed some works, I was simply able to execute them by enormously reducing the cost of the estimate as compared with the estimates of the engineer of the *Ponts et Chaussées*. The quantity of material which he threw away seemed to me monstrous; and when I spoke of it, he said, "Well, our object is not to do things in the cheapest way; we want to produce models of execution." I said that I did not think that spending so much more money upon a thing than was wanted was such an expenditure as would create a model; but his view was that he thought it should be something monumental, being a Government undertaking.

1599. You are probably acquainted with the bridge across the Rhine at Cologne. Would you make the same observation with respect to that?—No, that is a very fine bridge. I do not say that every work that is executed abroad is executed extravagantly. I make no such proposition as that; but I think that the general tendency of the system, especially in France where there is a government corps, is to produce an extravagant expenditure and an adherence to old methods with the object of being safe. A man in a government establishment wants to be safe above all things.

1600. In fact your observations would apply rather to France than to Northern Germany or to Holland?—Yes, because I have not executed works in those two countries.

1601. (*Chairman.*) The system of pupilage is extremely remunerative, is it not, to the engineer at

whose works the pupils are employed?—I should say that it was extremely remunerative. It costs him nothing, it gives him very little trouble, and very high premiums are paid. Then I may observe that that fact alone proves the conviction in England, that the pupilage system offers the best chance of advancement to the pupils. If an engineering college were really supposed to be a good thing, if any general belief to that extent existed, it would be instituted by private enterprise, and it would be a very highly paying institution; 100 young men paying 100*l.* a year, and they pay more than that, would keep an institution of that kind going.

1602. At present there is a feeling on the part of young engineers, that that preliminary scientific education is not required to make them successful in their profession?—I do not believe that they think about it; it is the older engineers and the parents that are to blame in the matter.

1603. Do you think that the Government must interfere in some shape, if higher scientific instruction is to be provided for engineers?—I am afraid they must. I think that those special technical courses are very much required over the country. I think that such professorships as, say, that of Professor Rankine's in Glasgow, and the professorships of King's College and at University College, and so forth, are exceedingly useful; and I am afraid that they cannot be self-supporting, inasmuch as the older engineers will not support them practically by insisting upon their pupils attending them; and the parents think they have done enough when they have made a man a pupil. I am afraid that like many other forms of higher education they cannot be self-supporting. If private munificence will not found those necessary chairs, I think it would pay the country well to institute them; that it would be a most remunerative speculation on the part of the taxpayers.

1604. If Government assistance were rendered, in what form do you think it could be most efficiently given?—I think by the endowment of chairs of engineering; and there must be several branches. There should be the civil and mechanical engineering, and probably naval engineering, and telegraphy; and the total or partial endowment of such chairs as those in existing institutions first of all, and secondly in such new institutions as I think it necessary to create. I do not think that the number of existing institutions is sufficient for the teaching of science independently of mere professional training. Then by the national administration of patronage a great deal could be done; support need not be given wholly by fees to the professors. If the college tests are allowed to count for something in the administration of the patronage, that alone will tend to fill the classes, by making it necessary for the pupils to go through that particular training; assistance may also be given by providing class-rooms and apparatus in the existing institutions. I do not think that the establishment, as I have already said, of special engineering colleges will be successful. Naturally men must go to those colleges, if that is the only entrance to Government appointments; but then we shall have Government engineers as opposed to civil engineers in a new form, and judging by what I have seen of the existing Government engineers, I do not think that the Government will get the best men. I might mention that I have some little special acquaintance with a special school of telegraphy, the school at Chatham where I lectured. The young men there were young men of remarkable ability, selected by examination, but they did not know a tithe of what was known by my assistants.

1605. Were your assistants much behind those young men in theoretical knowledge?—Yes, very much.

1606. When you said that they did not know a tithe of what your assistants knew, I presume that was in practical knowledge of how to operate?—Yes; if I had required to send out a man to a given station abroad to look after things, I should have taken one of my own assistants in preference to those men.



1607. (*Mr. Samuelson.*) Were those men specially learning telegraphy, or was it only a branch of military education?—It was only a branch of military education that they were at the time learning.

1608. (*Dr. Miller.*) Your assistants have been with you for some years, have they not?—Yes, some of them have.

1609. Specially devoting themselves to that subject?—Yes.

1610. (*Sir J. Lubbock.*) Then the cases are hardly comparable?—No, they are not strictly comparable; but even those men who have paid most attention to it in the military college were not so good, I think, as the pupils, and those men who have studied there for three or four years were not as good men as my practical assistants.

1611. Not as good men in practice, but better men in theory?—But what is the use of theory if you cannot put it in practice?

1612. But is not theory the foundation of practice?—No, I do not think so; they are separate things. However, I do not lay any very great stress upon that example, though it occurred to me as somewhat in point.

1613. (*Chairman.*) Do you think that Government assistance might be rendered in the shape of adopting the system of payment by results?—I think it may if you accept other results than the mere results of examination. For elementary schools, you may test, I think, the results of teaching by the results of examination; but I should altogether object to having another professional engineer examining my pupils, or a Government examiner examining my pupils, and deciding upon a mere examination what the result of the teaching given is. I think I am as much entitled to consideration on that point as he is, and I do not think that examination could be taken as a test; but I think something like a payment on results could be applied in this way. In founding the new chairs to which I have alluded, you might say, I will pay you for the next five years such a salary, and at the end of that time, if you do not have an average attendance of so many pupils, I shall consider that the chair has failed, and your appointment will come to an end; and that might be continued from five years to five years, taking the number of pupils who are willing to pay the fee as a real test of the utility of the chair. That would be a species of payment on results. Another class of assistance which might be made analogous to that is giving assistance to the foundation of a chair wherever the local authorities are willing to contribute so much; that is a real test of whether the thing is desired. Then assistance might be given where a given number of pupils stated that they were willing to enrol themselves to attend such classes.

1614. (*Dr. Sharpey.*) Might not a professor be tempted then to take pupils at a lower fee if his salary were to depend on the number of them?—I would not pay him in proportion to their number, and I would certainly fix the fee that the pupils were to pay; but in dealing with professors of the higher grades I do not think that you need put the same checks that you would upon a country schoolmaster. If the condition is that he is to have 25 pupils, and if those chairs were created in such existing institutions as King's College and University College, and Edinburgh University, you may be certain that the other professors would not wink at any fraud. The fees are fixed for us in Edinburgh by the University Council; we have nothing whatever to do with it.

1615. (*Chairman.*) Do you think that Government assistance might advantageously be rendered in elementary education according to the same principles as those which you propose should be applied to higher education?—Hardly. First of all, if by elementary education is meant education in primary schools, schools for the poorer classes, I do not think that you can teach very much there. For those I would rather see the application of the present principle of payment by results. The South Kensington system seems to me to do a great deal, and I would rather

see that system extended. But there is one addition to the teaching which I have very much felt to be very important, and that is the teaching throughout England of linear or mechanical drawing. I do not think that there is any subject whatever in which we are so hopelessly behind other people as in linear drawing and in the means of getting instruction in it. There is no considerable town, and I had almost said no village, abroad in which the poorer people cannot learn mechanical drawing; whereas there exist no means of learning it properly in the largest towns of Great Britain. Now I do not think that the people of England are at all aware of the great importance of that to the workman; it is almost as important to a skilled workman as reading or writing or arithmetic. If you understand mechanical drawing you can read all the books which are written about machinery, and understand them if they are not deeply mathematical; you can read all the engineering newspapers which contain a vast amount of information, and you can explain your own ideas, and put them down, and the mere power of recording their ideas gives the workmen a very much greater power of thinking. I look upon that, therefore, as the first thing that a workman ought to learn after he has learnt to read and write and to calculate. In England there literally is no machinery whatever by which a workman can gain this instruction. The present teaching in the schools of art where I have seen it (I have not seen it in London but only in Edinburgh) is really childish. There is no other word for it; and the workmen themselves feel the want of it so much that, in one case, they have set classes going, by so many of them, say 100 workmen, combining together to pay a certain sum each to try to get a draughtsman to teach them. I may just support my views upon this point by pointing to the report of the French Committee on Technical Education of 1863, in which they say that "drawing with all its applications to different industrial arts should be considered the principal means to be employed in technical education," and if they mean by that the education of the workmen, I perfectly agree with them. And, again, in this little book, containing a report by Monsieur Chauchard, in France, in the name of the committee appointed to examine the bill on technical education, I find that, "by universal consent, the art of drawing holds the foremost rank amongst the studies necessary for the artisan and the manufacturer." By drawing, in England, we generally mean freehand drawing. Monsieur Chauchard does not mean that; he means that among other things, but linear drawing in France and all over the continent, I should say, was more largely taught considerably than freehand drawing. I am certain that it is incomparably more necessary in this country.

1616. (*Professor Huxley.*) I presume, from what you have said, that you do not think that the conditions laid down by the Science and Art Directory, which provide instruction in machine construction and drawing, are at all adequate to encourage drawing of that sort?—It is impossible to exaggerate their inadequacy. I have got a few figures with me which will explain that inadequacy. In 1867 there were 17,210 students who learnt freehand drawing in the government schools; there were 105,695 taught drawing through the agency of the department; there were 6,583 teachers who received certificates of competency in freehand drawing; that may perhaps meet the requirements of the country in freehand drawing. Now for mechanical drawing. There were 13 teachers as against 1,583 who received certificates, and such teaching! There were 20 schools received assistance because they taught drawing, and such teaching! The payments for results were 34,851*l.* paid to encourage freehand drawing, and 340*l.* to encourage mechanical drawing. If you happen to hold the opinion that I hold, that mechanical drawing is much more important as a means of training to the working classes, you can imagine my anxiety to arrive at something exceedingly different from that. Then the total payment on re-

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28 June 1870.



Professor  
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F.R.S.

28 June 1870.

sults for scientific education was 5,000*l.*, as compared with 34,851*l.* for freehand drawing alone, and I do not think that drawing is so much more important than science.

1617. (*Mr. Samuelson.*) You are aware, of course, that there are training schools for this artistic portion of drawing, but none for teaching the teachers mechanical drawing?—I am not aware whether in the training school mechanical drawing is taught at all.

1618. The amount of mechanical drawing is so small that it is hardly worth taking into account; it is simply an accident, is it not?—It must be so, because the teacher in Edinburgh, poor man, teaches perspective and geometrical projection, and he teaches architectural drawing, machine drawing, and ornamental drawing. It is simply impossible that one man should teach all those things, and he told me so himself. He said, "My head goes round, sir, in that class. One man comes to me as a mason, wanting to draw buildings, and I have to try to teach him; an engineer wants another kind of drawing, and I do not know anything about engineering." It is not his fault at all, but simply that there is no machinery provided by which those things can be learned. I venture to recommend that teachers should be provided in Edinburgh, first, say, for teaching how to draw machinery and mechanical drawing, proper, then for building (I will not call it architecture, but building), and then for surveying drawings. I would provide advanced classes and elementary classes in each, the difference between a highly coloured finished drawing and a simple linear drawing being quite as great as the difference between an oil painting and a mere sketch. The same man cannot teach the two things. I think you would have in Edinburgh alone, say, 500 students easily. As to the number in London, I could not venture to compute it. In Glasgow there surely ought to be more than 1,000 workmen learning mechanical drawing. The desire that a workman has for that kind of drawing is very great. He knows his own deficiency, and he will unite with others to form classes to obtain the instruction. I have known two or three in London, and one in Manchester started by the men themselves, and they cannot find even a place to hold the class.

1619. (*Professor Huxley.*) There is this great argument in favour of what you say, is there not, that for a man to make anything of freehand drawing you must have some natural artistic taste, whereas a man may learn mechanical drawing thoroughly efficiently for all practical purposes without having any sort of artistic taste?—He may; the two things have nothing whatever to do with one another. As a mere matter of mental culture, I believe that mechanical drawing is the best of the two. People speak of freehand drawing as inculcating accuracy of observation, but I consider that the actual making of plans and sections with the true dimensions of an object inculcates far more accuracy of observation.

1620. (*Chairman.*) What steps would you recommend to be taken to provide a supply of teachers competent to teach mechanical drawing?—I think that the School of Arts system could be extended efficiently to the teaching of that branch of drawing. It requires large rooms and good light, and a considerable collection of apparatus, and I therefore think that you cannot look to private teaching. It might be objected that if this thing is so much wanted it would pay somebody to teach it, but it requires a very large outlay in the first instance, as for the schools of art, and the cases, I think, are quite parallel. I think there is no fear whatever of a Government system of mechanical drawing growing up. It is an elementary thing, and you can no more have a Government system of mechanical drawing than you could have a Government system of reading and writing. There might be a sort of fear of Government science as compared with other science, or of Government engineering as compared with other engineering, but that does not apply in the least to such an elementary thing as mechanical drawing. I would, therefore, have linear drawing

taught in connexion with the schools of art. I would appoint in each of those schools a sufficient number of teachers, who would be very easily found in the different branches of mechanical drawing (there are at least six different kinds of drawing that the workmen want), and those men should not be appointed by examination; they should be appointed from the recommendation of competent masters. Any engineer will tell you whether his draughtsman is a competent mechanical draughtsman or not. Very frequently those men know exceedingly little of geometrical projection, and descriptive geometry is a thing which finds hardly any application in practical drawing, and many of them are completely ignorant of it, although they are excellent draughtsmen.

1621. (*Mr. Samuelson.*) Would you teach mechanical drawing thoroughly in art schools?—I would, unless you built other schools of the same dimensions. If there is not room in the art schools, build other schools; but I would teach it upon the same system.

1622. But you would make it altogether a separate department?—A branch of it.

1623. So that those who required freehand drawing should learn that, and those who required mechanical drawing should learn that?—Yes. I would merely say that it should be in the same building, in the hope that the same superintendence and the same lighting might possibly serve the two purposes. If there is not room, new buildings should be provided.

1624. Just the same, I presume, as other science classes might be held in art schools?—I would not hold other science classes in art schools. I do not think you can call mechanical drawing a science.

1625. But it would require some knowledge on the part of the teacher of mechanical engineering, would it not?—It would require the knowledge that a mechanical draughtsman attains, the leading draughtsman in any engineer's firm, or the second draughtsman in any engineer's firm in London would be competent to teach a class of that kind.

1626. You are aware, no doubt, that art schools are established in many of the very smallest towns almost or villages in England?—I have no objection to their learning linear drawing in villages.

1627. Do you think that a competent mechanical draughtsman could be found in those places?—He would not, but a very moderate salary would induce him to go there.

1628. (*Professor Huxley.*) Would it do any harm to freehand students if they learned something of mechanical drawing to begin with, seeing the kind of drawing which is the extent in the art schools?—It would do them no harm, certainly.

1629. (*Chairman.*) Do you think that the same teacher would be able to give proper instruction both in freehand drawing and mechanical drawing?—Certainly not. I think in no case should they be the same. A man might possibly teach geometrical projection, which is a purely mental thing, and a man who was a good free-hand draughtsman might learn that, but I am certain that he could not learn what I call mechanical drawing. It requires, as Mr. Samuelson says, a great acquaintance with the details of machinery, and I think the only man who can teach that, is a man who is in the habit of drawing, and has been in the habit for many years of drawing machines, just as I think a man who can teach surveying is a man who has been in the habit of making surveying drawings.

1630. What are the means which the University of Edinburgh possesses of promoting scientific instruction?—We possess, I think, in Edinburgh, chairs in most, though it may be not all, of the pure sciences, and of some applied sciences; we have a chair of engineering, my own, and a chair of agriculture, and I think that the total sum which may be said to be spent upon all the science teaching annually in the University of Edinburgh may be about 3,000*l.* In addition to that, in Edinburgh, for the working men, there is an admirable little institution, called the Watt Institution, which, at a total expense of 390*l.* a year (of which 190*l.* only come from gifts, the rest being students' fees),



gives instruction to about 700 or 800 people annually, and gives it in the same sort of way as the University gives it by long courses of lectures, and by examinations. Then we have the School of Art which does next to nothing for science. Then we have the Museum of Science and Art, where there are courses of lectures of 12 each, without examinations; they can hardly be called classes, they are lectures. If I may compare humble things with large, they are for the poorer men something like what the Royal Institution lectures are for the richer classes; admirable things, but a man does not go to the Royal Institution to learn his business. I cannot say how much of the expenditure should be counted as applicable to that science teaching and how much to the museum, but the cost of that museum, reckoning the interest upon the first outlay is now, I suppose, about 14,000*l.* a year. As I have pointed out that art perhaps gets the lion's share in the freehand drawing, so I may observe, although I would not diminish the grant to that museum, I think it gets rather the lion's share as compared with the science in the University, and in the Watt Institution especially. And I think there would be no great inconsistency in founding several new technical chairs in the University, and in assisting that Watt Institution by grants made conditionally upon real results being attained. I should not wish to see professorships instituted which are mere dead things there. If they really are dead, and have no students, the sooner they are buried the better.

1631. Was the Museum of Science and Art established by government assistance?—Wholly, I believe.

1632. Is it of recent establishment?—It is of recent establishment, and is of the same kind as the South Kensington establishment. It is very largely attended, and it is the means of giving great pleasure, and, I have no doubt, of awakening a good deal of interest among the poorer class in Edinburgh. I do not wish to criticise it at all.

1633. Is the Watt Institution entirely a private institution?—It is the first, as it were, of the mechanics' institutes; it is a very old mechanics' institute, but it has had absolutely no assistance from the Government until very lately, and it gets from all sources, private donations, subscriptions, endowments, and everything, 196*l.* a year; and the results that it produces from that small expenditure are marvellous. I have had several students from there; they are all well trained in mathematics, and have a very fair knowledge of the elements of natural philosophy. Their courses are as long as the University courses.

1634. May it be considered to be a school?—It is a school for adult men; it is chiefly frequented by workmen; it is a night school, and not lectures merely, but classes and examinations and medals, and the whole system in little of a true university.

1635. (*Professor Huxley.*) Does the Watt Institution get no help from Government indirectly by fees under the science examinations?—I believe that the teachers did get about 70*l.* amongst them last year by means of the payments upon results, but I do not think that is enough. There is going to be a very great improvement, I believe, in the room which they have. Otherwise it has been quite pitiable to see the small room and the miserably scanty apparatus with which such very good results have been obtained.

1636. Did you count this 70*l.* in the sum that you have just mentioned?—No, that amount is the amount which appears on the balance sheets of the secretary of the institution, but the other goes to the teachers and does not appear in the balance sheet.

1637. (*Mr. Samuelson.*) The connexion with South Kensington, I believe, is quite recent?—Quite recent.

1638. Only within the last few years?—Only within the last few years; before that they were quite independent.

1639. They were scarcely aware, I believe, of the Government grant before they gave evidence before

the Committee of the House of Commons?—Yes; I have heard so.

1640. (*Chairman.*) Is there anything in the character of the Watt Institution that would render it possible for the Government to aid it without applying the same principle pretty generally to every mechanics' institute?—I do not know that there is. I think if the principles which I have laid down were acted upon, if you gave assistance where there were classes, where they were not a sham, but where there were really a certain number of pupils attending for a certain number of nights in the year, you might very properly aid such mechanics' institutes. The fault of mechanics' institutes is, there are no classes. You have amusing lectures in them, but a class with a course of 100 lectures can hardly be found. I do not know where there is any other instance.

1641. (*Mr. Samuelson.*) Is it not the case that assistance of that kind is available to mechanics' institutes under the South Kensington system?—Only by payment for results.

1642. And for apparatus?—Yes, and for apparatus, I had forgotten that.

1643. (*Professor Huxley.*) Would not the Watt Institution be able to obtain assistance from the Government in accordance with the regulations of the Department respecting building and apparatus grants?—I do not know those regulations as well as I ought.

1641. At the 21st page of the Directory of the Science and Art Department you find this: "Building Grants. A grant in aid of a new building or for the adaptation of an existing building for a school of science may be made at a rate not exceeding 2*s.* 6*d.* per square foot of internal area, up to a maximum of 500*l.* for any one school, provided that the school be built under the Public Libraries Act, or be built in connexion with a school of art, aided by a Department building grant. And provided that there is a population in the neighbourhood which requires a school of science, that is likely to be maintained in a state of efficiency, and that the site, plans, estimates, specifications, title and trust deeds are satisfactory." Then there is a further statement about the regulations under which building grants are made, and the next paragraph relates to apparatus grants: "A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them is made to science schools and classes taught by duly qualified teachers under the supervision of committees, constituted in accordance with the 10th section, page 4, and approved by the Department. If at any time it is found that the apparatus, examples, &c., towards the purchase of which a grant has been made, are not properly taken care of, the aid of the Department may be withdrawn. Grants on the same scale will also be made to schools or classes not under qualified teachers in cases where the total value of the apparatus required is not above 10*l.* As a general rule, no endowed school is eligible to receive a grant towards the purchase of apparatus, &c., unless considerable local contributions are made in aid of it, and then only when the apparatus is clearly necessary." Are you aware whether any application has been made in accordance with those provisions to the Department for help by this Watt Institution?—I am not; I think so far as that goes it is an excellent regulation. I would wish to see added to this a grant upon a much larger scale in proportion to the number of pupils, making the proportion not depend upon the mere size of the room which is about to be built, but upon the number of pupils who have been proved to attend such institutions, so as to enable them to grow, because I hold that institutions which grow of themselves are likely to be very much more useful than those which you attempt to create. You cannot make a mistake as to what is really wanted.

1645. (*Chairman.*) Are any of the professorships in the University of Edinburgh endowed by the State?—Yes, my own receives 200*l.* a year, and the chair of agriculture receives, I think, 350*l.* a year, and there are parliamentary grants which have been made in

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28 June 1870.



Professor  
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F.R.S.

28 June 1870.

consequence of commissions in times gone past, chiefly to the purely scientific branches of education.

1646. Would you like to see the number of Government professorships or the amount given to the professorships from the Government increased?—I do not know that the actual amounts paid to the professorships which exist require increase. I should rather like to see additional professorships, or lecture-ships if the subject is not sufficiently great for a professorship, and I should like to see them not made absolute, but made conditional upon the chair being a clear and decided success, not granting the endowment for ever and ever. We have chairs there now receiving 300*l.* or 400*l.* a year and teaching nothing. For instance, there is the chair of practical astronomy, which receives 400*l.* a year, and nothing is taught.

1647. Is the University of Edinburgh richly endowed?—No, it is rather poorly endowed, but still we have a very large number of students, and the professors' chairs are very much run after, therefore it is hardly an increase in the emoluments of the professors that is wanted. There is no difficulty in getting men to teach, and, therefore, though as a professor I should like to have all chairs handsomely paid, still I see that the appointment is desired, and therefore that increased emoluments are not absolutely necessary. The only change which I should like to see, but it is a change of such magnitude that I dare hardly recommend it or to suggest it, is this, I should like to see a commutation of the fees, or a commutation of one part of the fees for a fixed salary in consideration of an entrance examination. We have admirable professors; a professor of natural philosophy, and a professor of chemistry, and so on, and all those men are excellent men, but they get wretchedly prepared students. Men come up knowing nothing, and men of the highest acquirements are forced to teach elementary subjects. Now a man like Professor Tait is thrown away teaching elementary science, which ought to have been acquired in the second grade schools, and if we are ever to have a much higher grade of teaching in the University, we must have entrance examinations, and you cannot make those men insist upon entrance examinations if they are to do so at the penalty of losing three-fourths of their income.

1648. Is there no entrance examination at all?—None whatever. Any man, no matter how ignorant, comes, and there are enormous classes exceedingly ill prepared.

1649. (*Mr. Samuelson.*) Does that apply to arts as much as to science?—Yes, it applies as much to arts as to science; it is quite as much felt there.

1650. (*Chairman.*) At present, however, several of the professorships have considerable salaries attached to them have they not, independent of fees?—Yes, they have.

1651. But that does not apply in all cases?—It does not.

1652. Do you think that in all cases there should be a certain fixed salary?—I do. I think that the profession of teaching science is one that should be well paid. If a man is to be an investigator of science and not simply to try to make an income by getting the largest number of students of all kinds together, you must give him the material conditions of leading an easy life.

1653. Then the number of unprepared students who come is very great as compared with those who are really able to take advantage of the instruction which the professors are capable of imparting?—Yes; for instance, some of my students complained to me that Professor Tait had been obliged to spend two days in explaining to a class of 175 pupils the meaning of a sine in trigonometry; before lecturing upon light, it was certainly necessary that they should understand this; and two days out of a course of 100 lectures were occupied in that. That is a most unhealthy condition of things.\*

\* Professor Tait has since assured me that my students had exaggerated the time lost.

1654. Has the question of enforcing an entrance examination ever been under consideration?—Yes; I think that every professor in the University would like it, but we all say that it is perfectly hopeless to talk of it, for we cannot get Government assistance, and it is no use going to the Government.

1655. Then is the Government aid a *sine qua non*?—We fancy so.

1656. (*Professor Huxley.*) But is there not more than that; you must revolutionize the whole system of secondary education, must you not, before you can hope for it?—We could institute it at once as far as the professors are concerned. Then comes the question of whether or not there are any means by which this elementary education could be given. I do not think there are at present, not in schools. The High school has tried to do something, and I believe that they are honestly desirous of giving the required instruction, but the great difficulty is in meeting with competent men to instruct.

1657. (*Chairman.*) Are there no schools in Scotland in which trigonometry is taught?—Yes, but it is either not sufficiently well taught or not sufficiently learnt. I cannot explain that omission, but I quite find with my own students something of the same kind. The second grade schools are marvellously bad as regards the teaching of science.

1658. Are they worse in Scotland than in England, do you think?—I have no means of knowing. I have a suggestion to make in connexion with all those things and in connexion also with the aid to research which might possibly be given by the Government, a suggestion which I make very humbly, because it is, I own, novel, but it is worth perhaps criticising. I think that the judging of the applications for assistance, applications for the endowment of new chairs, and the application of Government patronage generally as regards science might be managed by the following system. Supposing that instead of the grant being given simply by the Department itself (speaking now of the Committee of the Privy Council) there were a representative board composed of men of science, composed of professors who could advise—I will not say that they should have the power of deciding—I would rather leave that with the Government, but that they should have the power of reporting at any rate upon each of those applications, I think that the Government would get better advice than it can command at present. My idea is that this board should be an elected board, that each of the existing colleges (you could easily choose the colleges and universities) should appoint one member at such a board as that; but however the choice was made, if there were something like a representative board of scientific men to advise the department, even if their recommendations were not necessarily acted upon, but that they were simply a reporting body, I think that the Government would be better able to decide on such subjects than they can now do, and that their decisions would give greater satisfaction.

1659. You have formed some views, have you not, with respect to Government patronage?—I think the suggestion I have just made applies to appointments, for instance, to vacant chairs, a large number of which must necessarily be in the hands of the Government, if any great extension of the present endowments is created; I do not know how otherwise the Government is to decide who is really the best man. We cannot have competitive examinations for professorships, I think, and the system of irresponsible testimonials has come to be in a monstrous state. A man really prepares a blue book; every man one has ever spoken to sends for a testimonial, and you get a whole library of those testimonials. It is a very difficult subject to know how such patronage should be administered, but I do not think that it would be a bad plan if those testimonials were referred to such a body as the council of one of our learned societies. I do not think that the council of any one could quite be accepted, but such a body as the council of the Royal Society is, might make what you might call responsible public



reports as to appointments. I do not mean that they should advise the appointment of a man, but they might say such and such has a claim, and leave it to the department to judge of the claims. I think that the department would feel itself very much relieved by having such advice as that upon which they could act.

1660. Have you at all thought of the number of members that you would like to see composing such a committee of advice?—I think that each distinct college, such as, in Scotland, the four universities, and in England, certainly in London, King's College, and University College, or any similar college which might be created in London, should each have its representative, and the Irish colleges and the old universities also; that would form a rather too numerous body to be consulted upon every occasion, but what would happen in such a council as that is what practically happens in all large councils, the question is referred to a sub-committee which is chosen by that general council, because they know who is really competent to form an opinion upon each subject, and the report would come up as the report of the sub-committee.

1661. Do you think that in any other respects the Government patronage might be so administered as to stimulate scientific professional instruction?—I think it might more than at present. I do not think that the plan of examinations for appointments, say in engineering, either has been very successful or will be very successful. No doubt any man who passes a good examination in anything, no matter how foolish the examination is, will be a man of some little ability; but I do not think that you can pick out the best engineer by an examination, certainly not in a room, and I think that if the Government could give any weight to the college test and to the reports of the engineers under whom their pupils have served, for instance, they might very largely stimulate work amongst young men, and they would fill the classes by a plan of that kind, but I doubt the possibility of selecting ready made men by examination.

1662. Have the Government any engineering appointments at their disposal?—Chiefly in India, where they have a considerable number; and as to the Indian examination I have not seen it for two or three years, but it was not an examination that I could conscientiously approve of. An examining engineer necessarily examines in the few things that he knows, and if a man is to be ready for examination in the whole range of engineering knowledge, he would need not to have begun his education but to have finished his life before he was ready to come up. The only possible form of engineering examination which I could advise is a system which I find already in action at Karlsruhe, and it is this, that the men shall have an actual piece of work given them to do. If, for example, they are examined in surveying, the examiner says, "I will give you a month, go out and do such and such surveys and sections, and so forth, and bring me back your work certified as done by yourself;" but excepting in that way I do not know how you can examine.

1663. (*Mr. Samuelson.*) The question of examination for an engineer's appointment is of special importance just not, is it not, in consequence of the Indian Government having determined to construct nearly all the railways themselves, instead of leaving them to private companies, which has hitherto been the case?—I think it is of immense importance. If there is to be a large corps of Government engineers like that, I would not select them ready made, I would make them and make them systematically. I would make them upon the same plan as I have suggested for telegraphy. I would take young men well prepared in pure science, and I would send them as pupils to the first engineers in this country or in India, and at the end of a certain period I would require this class of pupils to attend college, in order to acquire more special technical knowledge.

1664. (*Chairman.*) Is there any principle upon

which they are selected at present?—Yes, there has been a good deal of care taken to try to get the best men. One of the conditions is that they must have served a certain time under an engineer, and there is the condition that they must have attended certain schools which are supposed to give engineering instruction, and then there is the final examination. But the mere attendance at a certain school for a year, unless you give the professor the power of reporting the degree of efficiency, is useless, and the system of attendance under an engineer is shamefully abused. A man is nominally under such and such an engineer and he gets his certificate, "He has been under me for such a time," no work whatever having been done. Very frequently they get nothing but drawing, which they ought to have acquired long before they go there. Boys of 13 or 14 may be made most excellent draughtsmen.

1665. What is your opinion with respect to the duty of the Government in promoting original scientific research?—I think that original scientific research will really be most promoted by making the profession of a scientific man a somewhat better one than it is at present. If there were a very much larger number of chairs and decently paid professorships than there are at present, you would have a much larger body of men acting as scientific men. I am clearly of opinion that scientific research should not be made to pay; it should not be made a remunerative thing. I do not think there is any danger of that, but if it could be done I think it would be a very bad thing. You must not let men scramble for grants in aid which shall be grants paying the investigator. If any grant is made in favour of direct research it should be entirely for researches out of pocket, and I think that such grants as I have mentioned might be administered by the very same board that I have already suggested.

1666. (*Professor Huxley.*) Does not that come in reality to doing nothing whatever for the higher mathematics, because of course the higher mathematics involve no expense except the expense of living to the person who works at their application, and is not that practically putting a bar upon the higher mathematical education?—I think not: if you add those additional professorships even without any direct encouragement by grants in aid, and if you give additional institutions where additional institutions are really wanted, you will make the pursuit of higher mathematics more remunerative, and I do not think that with respect to grants in aid you could look upon the mathematicians as at all upon the same ground as physicists, because they are never out of pocket; the expense of pen and paper is nothing.

1667. But they are also never in pocket?—Quite so. When I say that additional institutions are required, I mean in places like Birmingham. There is Birmingham without anything, and there is Newcastle without anything, and I have no doubt many other large towns. It would be a pity to put two or three competing institutions in every existing large town. I should be sorry to see another university in Edinburgh. I do not think there is room for it, but it must expect to compete with Newcastle, with Glasgow, and other large towns.

1668. (*Chairman.*) Have you any hopes of seeing those additional scientific institutions which you think are required, established without the intervention of the Government?—Very little indeed. I hope that there will be instituted, with the assistance of the Government, institutions of the class of Owens' college, and of the class of the Edinburgh University.

1669. Partly subscribed to by private individuals and partly from the State?—Yes; and I hope that those would really be called universities, and not special schools, but that they will contain perhaps some chairs which are found to answer, and that when a chair is found to answer another may be founded of the same name.

1670. (*Mr. Samuelson.*) Those chairs being special chairs?—Yes; for instance, if a chair is found to answer in Edinburgh, found another in Aberdeen by

*Professor  
F. Jenkin,  
F.R.S.*

28 June 1870.



Professor  
F. Jenkin,  
F.R.S.

28 June 1870.

all means, and if both classes fill, found one in St. Andrew's. Keep up a healthy competition amongst them, but if you find the chair of practical astronomy is absolutely empty at Edinburgh do not found another at Aberdeen.

1671. You said, with reference to engineering appointments, that you would rather make the persons to whom you would give employment than take them ready made. Would not that be a rather hard case at this moment upon the numerous men of middle age, who are unemployed as civil engineers?—It would be so certainly. When I said that I would rather make them than take them ready made I was not thinking of the higher appointments. I was thinking of the young men who come to me, who are going up for examination. You cannot possibly appoint to the higher appointments, by examination, and those men of middle age would really be qualified for the higher appointments.

1672. All you meant to say was that the raw material as you find it now is not satisfactory, and you would do something more with it before you would allow it to act?—I mean this, that in the preparation of the raw material I would follow the plan that I have suggested of choosing men at an earlier stage in their life than after they had completed their professional education, when they have done nothing practically by which you could judge of them and when you cannot satisfactorily examine them.

1673. You are aware, no doubt, of the circumstances under which the special schools, or many special schools, were originally established on the continent, for instance, the *Écoles des Arts et Métiers* in France, and the Polytechnic School in Berlin?—Yes.

1674. At the time when those schools were established there were no manufactures, or scarcely any manufactures, and there was no engineering practice?—Precisely so.

1675. Are you not aware also that since then circumstances have changed on the continent, and there is a tendency to abandon the system of teaching the mechanical arts in schools?—I think there is. I think there is a strong reaction against it.

1676. And that in some of the more modern polytechnic schools, for instance, those of Zurich and Carlsruhe, the pupils are recommended to make a break in their instruction, to take the theoretical courses first, next to enter a laboratory or an engineering establishment, as the case may be, and then to return for scientific instruction in the more technical departments?—Yes, I am aware that that is recommended, and it almost precisely coincides, as you observe, with what I wish to do; but I do not find that this is as yet very largely acted upon.

1677. But so far as it is acted upon, that is precisely what you would like to see done in this country?—Except that I should not like to see the theoretical part given in a special school. I would rather see it given in what may be called a university.

1678. (Sir J. Kay-Shuttleworth.) Did I rightly understand you to say that you prefer that there should be some practice in the workshop before students receive scientific instruction?—No; theory first, practice next, and application of theory to practice, last.

1679. You would not give any preliminary instruction in the workshops?—No; the instruction in the workshop is the practice for mechanical engineering.

1680. (Dr. Miller.) I think you said that you had great difficulty when students came, in making them understand simple expressions such as connecting rods?—Yes.

1681. I also understood you to say that you would not object to students, in their earlier course, being taken through the workshop and seeing the machinery in operation, together with illustrative lectures?—No; but a man ought not to come to me before he has been at real work. The students who, I find, practically benefit from what I teach them are men who have already been in contact with real work.

1682. (Sir J. Kay-Shuttleworth.) Yours is a technical course, is it not?—Yes, mine is a technical course. I should like them to take pure science first, and then come to the technical teaching.

1683. (Mr. Samuelson.) Are you aware that there is great confusion in men's minds between such special courses as yours, and laboratory instruction in colleges?—I think that there is a good deal of confusion. I think that people, however, are coming to understand it better.

1684. Is there not one ground for special courses such as yours, that there is a tendency in the workshops to subdivide the labour almost infinitely?—Yes, there is.

1684. For instance, one man shall be occupied with the construction of hydraulic apparatus, and another entirely with the construction of locomotives, and another of marine engines, and so on?—Yes.

1685. And that unless the pupil had the opportunity of attending some general course in his special department of art, his knowledge would be limited simply to that small division of his art, which he would have learnt in the workshop?—That is quite true; I do not see how any man can learn thoroughly more than one or two branches, but unquestionably the attending of a general course of lectures upon the subject will show him how the principles are applied to his particular branch, and will enable him the better to apply those same principles to any other collateral branch of which he has not a detailed knowledge.

1686. So that he would be a better locomotive engineer for knowing something of marine engineering and *vice versa*?—Yes, certainly.

1687. (Professor Stokes.) Do I understand you to recommend that in the case, say, of civil engineering, the whole apprenticeship should begone through before the student comes to the lectures of applied engineering?—I do think that either the whole should be gone through, or that he should attend them during the last six months of his apprenticeship. I have men in Scotland, who are very hard working, who come to me and attend perhaps one other course in the university and do their professional work at the same time, but their habits are so remarkable as to hard work, that I do not know whether anywhere else it could be done. I have men coming and attending my course at 9 o'clock in the morning, going to their work at 10, going on with their work, with only the dinner and tea hour, till 9 o'clock at night, and then doing my exercises and keeping near the head of the class.

1689. (Dr. Miller.) Are they workmen?—No, they are not workmen; they are men who are in offices as draughtsmen, and as assistant engineers. In the borough engineer's office I have one case.

1690. (Mr. Samuelson.) From your knowledge of young men in England, you do not think that that is a system that would be very generally applicable?—I feel very much convinced that it would not. It certainly could not have been applied to University College; my students did not work there.

1691. Have you attempted, at all, to introduce the plan which you prefer in Edinburgh; have you recommended those who have applied to you to go through a preliminary apprenticeship?—Yes, I have, and one firm has made it a condition of the articles which they sign with their pupils, that they shall attend my course, not after the conclusion of their apprenticeship, but during the apprenticeship, which is the next best thing. They say, "You shall be with us five years," I think it is, "and two winters you shall spend at the university in such-and-such classes." That, I think, will work exceedingly well. I would rather have them at the end, but in the middle is better than not at all.

1692. Do you think that that is likely to be adopted by the engineering profession generally?—I think it will in time, but the engineers are persuaded of the correctness of their own old system of teaching, and they are difficult to move as a body; but it would grow upon them if engineers generally would adopt the plan of insisting upon the attendance at King's



College, or University College, in London, of their pupils during a part of their apprenticeship, the latter years, it would grow upon them, and it would give them what they now require, and if, in addition to that, they would not take a man as pupil unless he had passed a certain examination, we should have admirably educated engineers in England.

1693. Do you think that unless our engineers become more scientific, they will be in great danger of being distanced by continental engineers?—Hardly that, although I do think that they would be very much better for having a greater dose of science. I do not think that they would be beaten; I think there are so many conditions favourable to success in England; the amount of capital, the natural bent of the country, and the system of natural selection, by which the weak man invariably goes to the wall.

1694. Do not you think that those conditions are beginning to prevail very much in the North of Germany?—Yes; I think that we cannot keep the supremacy that we had at first starting, and that we shall not keep ahead without some effort.

1695. With reference to railways being made in Hungary and Turkey, and in Eastern Europe generally, are you aware that the competition with the North Germans is becoming very seriously felt?—Yes, it is.

1696. You stated that the want of theoretical knowledge was likely to make itself felt in the art of telegraphy; can you illustrate that?—I can illustrate it in this way. The men who are now being sent out upon very large salaries to different stations that I know of are, I consider, incompetent; they are incompetent to test cables, to find out whether cables are in a good or bad condition. Their theoretical requirements are far below what I think necessary. I cannot find men to recommend for those appointments.

1697. And you think that without theoretical instruction, no amount of practice is likely to qualify them?—I think not. The other cases are exceedingly exceptional. One of the best electricians in England was a watchmaker, and another was a plumber; but those men have been very exceptional men, and under any system whatever, however bad, such men gradually get the necessary knowledge; but if we are to educate an average man we must provide him with some plan by which he can get knowledge.

1698. I suppose you would say as to those exceptional cases, rather that they are self-taught than that they are untaught?—They are self-taught.

1699. You are aware, are you not, that the Government grants in aid of science are increasing very much from year to year?—Yes, I am happy to say they are.

1700. Supposing that it should be found necessary or expedient to place a limit upon them, would you consider it more important that aid should be given upon an increased scale to elementary science, or that a portion of the fund should be diverted to more advanced science; I am asking this question with reference solely to the economy of industry?—I really do not know.

1701. Would you consider it more important that the workmen should be taught or that the managers should be taught?—The managers. The workman I regard as the producing power, and his power of producing is very little increased by scientific teaching. I do not suppose that a workman in an engineering works would produce very much more, though perhaps he would produce a little more, by learning mechanical drawing.

1702. The chief economical advantage of teaching workmen would be, would it not, that you would get a larger field from which to select your foremen and managers?—That is one advantage, and that he would be a more intelligent being.

1703. But so far, merely, as the direct industrial result goes, would not the formation of one good manager be an equivalent to the instruction of a large number of workmen?—I should fancy it would; I think that if you simply want to produce wealth you ought to get the most highly trained managers possible, and make

your men into the merest possible machines. I do not think that that would be a desirable result; but if you look purely to the production of wealth, each man should do as much as possible, and do it from sheer skill.

1704. When we are told that the superior scientific instruction of the continental nations is aiding them in material production as compared with this country, you would apply that rather to the managers and the foremen than to the workmen?—Yes. I have not met with scientifically educated workmen abroad. The only superiority that I have found in the instruction has been in the drawing, and one advantage of that is, that a much larger number of workmen can make drawings and understand drawings than in England. I have not met with any workmen of the class indicated in the question.

1705. Nor do you believe them to exist?—I do not think they do.

1706. In speaking of the workmen being better instructed in drawing than in this country, to what nations would that more especially refer?—Both French and German.

1707. Do you think it possible to instruct workmen in science till they have learnt to read and write?—No, I think that you could only teach those workmen science who are selected by themselves by the interest that they feel in these things, and who come voluntarily to adult classes, such as are given in that Watt Institution. Their very attendance upon those classes proves that they are remarkable men.

1708. If you found a vast increase in the number of scientific students in the elementary classes within a very short space of time, would you not regard that with some little suspicion?—I should have to know a great deal more about the special circumstances of the case before I could judge of it. I should perhaps regard it with some suspicion, because, if I may say so, I regard everything with suspicion.

1709. Would you think that the testing of the knowledge should be all the more particular if you found that a large number of men were devoting themselves to teaching science, and that a large number of pupils came up upon the results of whose teaching the teachers were claiming payment?—Certainly the examination should be a strict examination before the payments were made, but I do not know that I would increase the strictness of the examination, simply because the number of men who came up increased. If the examination were originally a fair one, and one that really did show a certain degree of proficiency, I think, looking at the 5,000*l.* only which is paid for results in any particular year, that is so small a sum, that before I should dream of putting a limit upon it, it should amount to a great many thousand pounds more. The increase has been very great, in 1867 it was only 5,000*l.*, and now it is 34,000*l.*

1710. (*Dr. Sharpey.*) How many courses have you given in Edinburgh?—I have given two winter courses and two summer courses, and one course of mechanical drawing. I have actually tried to introduce that myself into the university, though I regard it as belonging more properly to elementary or second grade education.

1711. What has been the attendance of pupils?—The first year I had 24 in my winter course, and the second year 26. In the summer course the number is much smaller; 5 the first year, and 12 the second year.

1712. Were they intended to be professional engineers?—Yes, all of them.

1713. Your course does not include pure science?—My course is not a purely scientific course. I find, just as Professor Tait has to teach trigonometry, so I am obliged to teach for a portion of my course statics and dynamics.

1714. But you really think that your pupils ought to come prepared in the subjects of pure science?—Yes; I am able to send a certain number away without a preliminary examination at all. I tell them

*Professor  
F. Jenkin,  
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28 June 1870.



Professor  
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F.R.S.

28 June 1870.

"You are not fit to come here, I see that you must go away and come back again." I am able to tell them that, because my salary is already sufficiently large to pay me for that particular work. I get 400*l.* a year, independent of the fees, so that I can reject a man if he is not sufficiently prepared.

1715. Then you have a preliminary examination have you?—Not exactly that, but in the first examination at the end of the first week the answers to the questions show me and show the men themselves whether they can follow the course.

1716. I think I may gather from that reply and what you have previously said, that you would prefer that students of your class and similar classes should be tested as to their fitness to enter by an entrance examination?—I should like it very much.

1717. And a tolerably strict entrance examination?—Yes, a tolerably strict entrance examination.

1718. Something like what was used for some of those French schools?—Not so strict as that.

1719. Such as the *École Chaptal* for instance?—Not such as the student could take on leaving the *École Chaptal*.

1720. Or such as the *École Centrale*?—No, that would be too strict. It might come up to that in the course of a few years, but at present I should have only, perhaps, two pupils. I do not think that there are more than two a year who come to me that could pass that entrance examination at the *École Centrale*.

1721. You think that in course of time and by proper arrangements it might be brought up?—It may get a good deal higher, but I doubt its getting so high as that.

1722. As to the source from whence your pupils obtain this education in pure science, I presume that they obtain it in the University of Edinburgh?—They obtain some of it in the University of Edinburgh, and some in preparatory schools, such as the High schools.

1723. But, of course, in any of the other Scottish Universities they might obtain the same training?—They would get the same training, or at Dollar. I get well-prepared students from Dollar.

1724. In short, you would not wish to confine them to any particular establishment, provided they gained the instruction?—No.

1725. You, as a rule, prefer, I think you said, that there should be such institutions throughout the country where that amount of pure science might be obtained?—What I might call a science school as distinguished from a classical school. I think there is the greatest want in that direction.

1726. How could those schools be aided by the Government, do you think?—I do not see how the Government can aid them. A second grade school for the middle classes is a paying speculation, and the proprietors of those schools get up what suits the parents, and, except, by acting upon the recommendations of the Schools' Inquiry Commission with respect to the grammar schools, I do not know how Government can aid them, but I think those recommendations should most unquestionably be acted upon.

1727. So as to utilize the resources of the endowed schools throughout the country?—Yes, those endowments should be in part devoted to the formation of science schools, and to creating bursaries for science, and things of that sort, in different places all over the country.

1728. In the case of scholarships founded by the Government for proficient students, might not those be available for various schools?—Yes, they might; but to attempt to meddle by direct grants with the education of classes who can pay, and do pay for their own education, is a thing which I should view with very great suspicion, and I do not know how it is to be done.

1729. (*Professor Huxley*.) It struck me that in some of your replies to Mr. Samuelson you and he were a little at cross purposes as to the meaning of instruction or teaching in science. I should like, therefore, to ask a question or two about that. I

presume you did not mean to convey that it was impossible to give a certain amount of instruction in elementary science, which should be very valuable and very genuine to boys and girls, we will say between 12 and 16?—Certainly not between 12 and 16; a boy of 13 can be made to understand chemistry uncommonly well, and geometry exceedingly well, and elementary physics also. I have seen schools, for instance, the *École Chaptal*, in which classes of boys of 13 or 14 were receiving real instruction in science.

1730. You are aware, are you not, that until the last few years there has been absolutely no means of giving instruction of that kind to persons who are reached by primary instruction in this country?—Little or none I fancy. I am not so well acquainted with that subject as I could wish, but I think it was little or none.

1731. Supposing, therefore, that competent teachers could be found, and it were worth their while to give such instruction, there would be nothing to prevent a very rapid increase in that instruction?—Not if the teachers were competent, I do not think there would.

1732. So that we come back to the question which Mr. Samuelson put to you, the doubling or the trebling in the course of four or five years of the number of young people under instruction in these matters would not really be the slightest ground for supposing that the instruction was unsound in itself?—The mere doubling of the numbers would not. I fear that I am not acquainted with the facts which are being alluded to, and any apparent great increase would, I think, call for examination to ascertain whether it were due to a real increase of instruction, or whether people were being brought forward merely for the sake of swelling the results.

1733. I could put before you the facts upon which Mr. Samuelson has argued. It is a matter of fact that the number of pupils under examination in connexion with the Science and Art Department has very largely indeed increased within the last four or five years, for instance, this year I should think there must be in some branches 50 per cent. more under instruction than there were last year; but you must understand that the system of examination has been conducted by the same persons throughout that time; that the proportion of rejections is exceedingly high, and that so far as we know there is evidence to show that the examiners do their duty; under such circumstances should you think that there was anything remarkable or suspicious in the increase of the number of persons under instruction?—No, I do not think I should, because not only of late years has there been an increase in the number of teachers perhaps, but also the number of schools that are acting under those regulations have very considerably increased. Look at Edinburgh, the Watt Institution, I know, this year has sent up a considerable number of people, but either they did not know, or did not choose to avail themselves previously of those regulations, and I daresay there may be a considerable number more instances of that kind.

1734. You were speaking just now, with approbation of the recommendations of the School Commission. We have reason to think from a document which has reached us from the present School Commissioners, that it is contemplated to employ a part of the endowments at present at the disposal of education in the country, to the setting up of schools for science, with a special scientific direction, apart from the classical schools. Do you think that that is a good recommendation or a desirable one?—I do think it is. I think that where you have large schools which are divided into two sides, the classical side and what is called the modern side, there will be a rivalry of a bad kind, that the one will be looked upon as superior to the other from some ancient associations. Very generally, hitherto, the modern side is looked down upon as an inferior commercial thing; it is too often spoken of as if it were a fit preparation for the lower walks of life, and that men who were going to be



statesmen and lawyers should go into the old school, and the mere tradesmen and professional people should content themselves with the modern side. I think that is a very unhealthy state of things, because I believe that science will afford just as good culture as classics ever have done. I am not prepared to say better, but whenever we get sufficiently cultivated men to teach science in sufficient numbers, it will afford an excellent culture to the mind. I would rather see a separate science school with its own traditions, and with its antagonism to the neighbouring classical school as to which will turn out really the finest men, than I would see one school divided into two parts.

1735. Do not you think that both literary and scientific training is each of them necessarily one sided, and that the establishment of separate schools for those things would tend to exaggerate the evils of both?—I think it would do so, if you were in your science school to banish literature altogether, and if from your literary school you were to banish science altogether, but I do not think it would do so if you keep a sufficient tincture of letters in the science school, and a sufficient tincture of science in the other school. The sort of rivalry which I should like to see, is the rivalry that exists between Cambridge and Oxford, one being distinctly more mathematical, and the other distinctly more classical. I doubt very much any one university performing the function of those two.

1736. Is it not possible to suggest another method by which the foundation of all education shall be scientific, and the superstructure in the one case literary and historical, and in the other case more particularly scientific; and would not that be a better arrangement, seeing that science is at the bottom of all modern thought whatever and of all methods of thinking?—That would be so great a revolution that I am timid about it. I dare not venture upon it. I believe that I have observed that in some children, even from the very earliest age, there is much greater aptitude to take in literary training, and in others much greater aptitude for scientific training.

1737. Still there is a general training in certain kinds of knowledge which is necessary for all mankind, is there not, and it is well that all persons should have that foundation. You suggest a preliminary scientific examination through which persons going to the special study of engineering should pass, do you think it possible that that preliminary scientific training which is required for such examination should be made common to all the scientific professions?—Quite so.

1738. Would not that very possibly do away with some of the great difficulties which at present exist in all scientific professions, because we have a mass of raw material, as for instance in your own class, a number of engineers who come up occasionally incapable of understanding what they are to be taught?—Quite so.

1739. Would you see any objection, for example, to medical men, who are trained as specially as engineering students, going through this preliminary scientific examination?—On the contrary, I think it would be exceedingly desirable that they should get, and in the very same schools too, that training which I would give to engineers. It would be a monstrous pity if we took our young men and separated them off very early in life into exceedingly different classes. I would keep them together as late as possible, and that is one of the reasons why I should like to give those special courses to which I have alluded in what may be called universities. I should like to see the medical men trained there side by side with the engineers.

1740. Would not that involve the necessity of special courses in the university? Do you think that you could oblige the arts men to go through the same course of scientific study as those gentlemen who are intended for the more particularly scientific professions?—I am looking to their getting their scientific training sufficiently early to enable them to begin

engineering actually before they go to the university. As you say, young men can learn chemistry, natural philosophy, geometry, and trigonometry between the ages of 13 and 16, with which I thoroughly agree; I think that they should get that training in other schools, common to all, up to the age of 18.

1741. Do you think that sufficient preliminary scientific education for the purposes of an engineer and for a medical man could be obtained in the ordinary schools practically before the age of 18?—If the school were good enough, I have no doubt of it whatever. You do not require the higher calculus in engineering, though a certain number of men will always take to it as a pleasure, and will have a certain advantage from it; but the necessary amount of mathematics in ordinary use, algebra, geometry, trigonometry, and those things could easily be learnt. The very examination, to which I think Dr. Sharpey alluded, for entrance to the École Centrale, is quite enough, if a man could pass that examination, to qualify him to begin the practical work of engineering.

1742. So far as engineering was the business of their life, you would not contemplate students passing through the universities at all?—Not until they came to those special courses.

1743. Then you would have, so to speak, technical courses in the universities?—Yes.

1744. But that would be something grafted on, so to speak, to the body of the university itself?—Just as much as my chair is grafted on, for instance.

1745. But there is no reason, in the nature of things, why your chair should not be somewhere else; it is not any better for being in the university?—I think it is the better for being in the university. I think my students are better for the students that they meet. I think that I myself am better for the professors that I meet with and associate with.

1746. But that association might take place, might it not, under quite other conditions?—Yes, but I also get the benefit of the buildings and all those things.

1747. You seem to object to any competitive examination; would you have the same objection to a final pass examination, that is to say, to make sure that every man had acquired a certain minimum?—No, I should not feel the same objection to that.

1748. I ask you the question with particular reference to medical education, which is, perhaps, in its way, though it is in a very incomplete state, a sort of model of technical education?—It is a valuable model of technical education.

1749. There you are aware that the competency of the student is tested by a pass examination?—Yes.

1750. We do not make medical men such by competition, but you would have no objection to something of that kind?—None whatever. I should not like to say, that no man should practice as an engineer who had not taken a diploma as an engineer. There are qualities in engineering which do not admit of being tested by any examination whatever. There are many men who have already distinguished themselves without that special and theoretical acquaintance with science; but for the Government appointments, if your object is to keep out incompetent men, a pass examination at the end of their studies would be very useful.

1751. The same argument might be used in medicine; there are men, here and there in the country, who call themselves bone setters, who have most extraordinary facilities in reducing dislocations, where a regular practitioner can do nothing, but yet, looking to the advantage of society, probably it is a better thing to make medical men go through a pass examination?—Yes, but those men that you speak of as bone setters are very few, whereas there are a great number of instances of engineers rising to eminence, and, with but little education, doing the greatest things.

1752. I gather that you have no objection to technical qualities as such; you do not think that all

*Professor  
F. Jenkin,  
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28 June 1870.



Professor  
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F.R.S.

28 June 1870.

technical education is in itself bad or useless?—No, I do not think that it is in itself bad or useless.

1753. We have had somewhat strong evidence to the effect that all technical education is bad and useless, but you do not agree with that?—If you mean by technical education, attempting to teach a man his business by a college course, I think it is a very mischievous delusion indeed; but if you mean that, in addition to his practical training, you would give him some theoretical training, some technical courses (I do not know any better word), I think that would be very useful.

1754. I presume that in the minds of rational men, the object of a technical college is not so much to teach a man his business as to prepare him to learn his business?—That may be what is meant in the minds of rational men, but such a thing does not exist anywhere in the world.

1755. Do not you think that a medical school really seems to you to be a place where a man is taught to be able to learn his business?—I think not, because as soon as he comes out of the medical school he begins to earn his livelihood, or he tries to do so; and, in the same way, as soon as an engineer leaves any of the foreign Polytechnic schools, whether the German or the French ones, he immediately begins to earn money: a man can hardly be said to be educating as soon as he begins to earn money.

1756. But my question went to this, whether you would contend that a technical college prepares a man for his business in engineering, in the same way that in a medical school you prepare a man for his business in medicine?—But the medical man begins to practice the moment he leaves the medical college, whereas the engineer cannot begin to practice, with advantage to himself, the moment he leaves the engineering college. It would be better for him, if he were able, to go to a place where he had a right to say, I wish first to see this branch and then to see that, and then to go by rotation to a number of different works; to go to railway works, canal works, and harbour works, one after the other. It would be better for him to do so. I do not think that anything in the paid work of an engineer would supply the place of an unpaid pupilage. An engineer cannot afford to give a sufficient number of years of his life gratis, to take, say, the foreign technical college first and then the practical pupilage. Now, a medical man (I speak, of course, under correction) does find some real practical work, not perhaps to do, but to see very closely in the hospital. If I could concentrate railways, canals, harbours, roads, and telegraphs into a kind of engineering hospital, I would not object to a technical engineering college, but I do not think you can have that.

1757. Then your objection would apply specially to an engineering college, but not so much probably to a metallurgical college?—I cannot speak of a metallurgical college, not knowing the subject.

1758. Would your objection also apply to telegraphy. It would be possible to have a telegraphic hospital, would it not?—I think not. You may have a wire really 600 miles in length represented, as regards certain phenomena, in a little box, but you cannot represent the thing itself. A museum of telegraph posts and wires and bits of cables are poor representatives of the real thing.

1759. You do not think that there is as near an approximation to actual work in that case, as looking on at an operation is to the doing of it; that there is a greater gap between theory and practice?—There must be, for the medical man sees the actual operation at any rate, he does see the true thing, whereas an engineer at a college does not see the true thing. Even where attempts are made to approximate to the workshop, as in the *École des Arts et Métiers*, it is not the true thing.

1760. Not so near an approximation as in the other case?—No; the approximation in the other case is analogous to this, that I and my principal assistant test the cable together, and my pupil looks on, he perhaps puts down some figures or asks for a little

explanation. That will take up a few moments, perhaps, and he sees the way that I do it. The next time that pupil has to test a cable, he does not know all about it, but he has seen the real thing in a totally different way from that which can be produced in the lecture room of a college.

1761. You spoke of the establishment of a board of scientific advisers for the Government; does not the French Institute at present play very much that part?—I am not sufficiently acquainted with the functions of the Institute to say.

1762. Does it occur to you that there is any very real practical difficulty in the system of a responsible body making reports which are practically public?—Yes, I see some difficulties.

1763. That is to say, there are a number of questions affecting the efficiency of a man as a professor; questions, for example, as to his disposition, and as to the manner in which he has worked with other persons upon which it would be impossible to report openly. I have no doubt your experience, like that of most of us, would yield you instances when you are reporting upon a man's fitness for a post for which he was applying, you have been governed very much by considerations of that kind?—That is quite true, but whether your report should be public or not, is another matter. Publicity is a most excellent thing, but it may be carried too far.

1764. A report confined to the purely intellectual or scientific qualifications would not really, in many cases, bear upon the fitness of a person for the office of professor?—It would not be sufficient by itself. I think not.

1765. You are doubtless aware that there is a plan on foot now for setting up an engineering college in this country for the Indian service?—I have simply seen it mentioned in the newspapers. I should be sorry to see it adopted. I think that they would get better men by the other plan.

1766. I understood you to say, in speaking of Scotland, that you thought an engineering chair useful in Edinburgh, and that it would be a very proper thing that another chair should be set up in Aberdeen, and another chair set up in St. Andrew's; by what body do you contemplate that those chairs should be set up?—I think the endowment should come, in part at any rate, from the Government, and that the body who should dispose of it should be that kind of general representative body who should report upon the desirability of selecting the particular candidates.

1767. You have no objection to State competition, *per se*?—If you call that State competition, I have no objection to it whatever. If, however, you mean that there should be one college which should be a State College, and that the appointments should be given to the men who come out of that college, say for the Indian Service, that is not competition. I object to that entirely; I say that that is a Government monopoly, and I should be sorry to see what may be called a Government school of science, upon the same ground, administered by a central Government department which should decide upon the examinations, so that all of them should be alike. I think that in that case there would grow up, what exists in France, Government science, and I think that does tend really to numb all the scientific energies of the country.

1768. But you have no objection if the facilities offered to all schools were alike, the State supplementing private enterprise by establishing schools of its own?—I have no objection to their establishing schools of their own, provided they do not manage them. I should like to see them after they are started, managed by local boards of some kind, by a senatus, or by university councils. I should like them as soon as they were born to be cut fairly adrift from the State, or that they should not depend upon a Government department any more than the older universities do. I think Owens College, for instance, a most excellent type, not to take my own university,



which I think also is a very successful university. I should be very sorry to see a set of Government establishments, managed by the Government, competing with others. Even if there were an attempt made, I think it could only be an attempt to deal equally with them all.

1769. Are you aware of any existing body which is in that sense managed by the Government, that is to say, where the Government does not rest in hands which correspond with a senatus?—I do not know the management, for instance, of the School of Mines, which is supposed to be a Government establishment. I do not know the management of the training college at Dublin, or of the Queen's Colleges, and I do not know how those things are done.

1770. Are you not aware, as a matter of fact, that the whole Government of the School of Mines is placed in the hands of the professors?—No, I was not aware of that.

1771. Scotland has a population of about 3,000,000 of people, has it not?—About that.

1772. If there is no objection to establishing extra scientific bodies for teaching by the agency of the Government in Scotland, I presume there would be no objection to the State doing the like in London, which has a larger population?—On the contrary, I think very probably there is room for a third institution, besides those which at present exist; provided, as I say, it was not more favoured than those are; what is given to the one should be given to the others. I do not know that I said that there was room in Scotland for more than four universities. I doubt very much if there is room for a fifth university, but I think there is plenty of room for fresh chairs.

1773. What the establishment of engineering chairs in other universities comes to is, really, the setting up of technical schools for engineering in those universities; that is not what you desire?—Certainly not. I do not wish to set up technical schools, but to add some technical courses to the purely scientific teaching now given in universities.

1774. (*Sir J. Kay-Shuttleworth.*) I have understood you, through your whole examination, to say that you thought that there was plenty of work for additional scientific schools?—I think there is.

1775. And I think in some part of your examination you mentioned some of the great centres of industry in England as being proper places for the establishment of scientific schools; you mentioned Newcastle and Birmingham and other centres of industry?—Yes, and perhaps Bradford might be added to the number.

1776. I also understood you to say that you greatly preferred that after scientific instruction had been given to the students in such schools, provided they were intended for any department of industry, for example, engineering, they should then proceed to the workshop?—Yes, or the works generally.

1777. That they should spend their period of pupilage, after having received their scientific instruction, in actual work in the department of industry to which they were to be devoted?—Yes.

1778. Would not the establishment of a scientific school in such a centre as Manchester afford abundant facilities for the period of pupilage in machine works, in mining, particularly coal mining, and even in other departments of mining, lead mining in Derbyshire, and various other industries, after the period of scientific instruction?—No man could be probably in a better place for that purpose than in Manchester.

1779. Then probably the establishment of such an institution as Owens' College would be carrying out your idea, provided there were superadded to it technical instruction from special chairs?—I think it would exactly carry out my idea if, in addition to the present chair of engineering in Owens College, you

instituted lectures in telegraphy, and possibly a professorship of agriculture, or a chair of mining, the special duty of which should be to point out the peculiar applications of science to mining and some other subjects. In Liverpool, for instance, there would be necessarily a nautical chair and a chair of naval architecture. If you were to do that, that would be carrying out what I wish to do.

1780. Those schools would differ from an ordinary technical school in this respect, that there would be in Owens College first a chair of pure science?—Yes.

1781. And the course of the pupil would consist first of instruction in pure science, then a pupilage in art or work, and subsequently technical instruction, by means of chairs devoted to particular departments of industry?—Yes, but the amount of technical instruction by special chairs would, you observe, be very much smaller in proportion to a man's life, than the amount of instruction in a foreign technical school. The foreign technical school, having to teach everything before a man earns his bread, has to take five years of those special courses, which really need not take more than perhaps six months, at the end of the pupilage.

1782. Do you conceive that it would tend greatly to promote the success of such a college as Owens College, if the secondary schools which are aided by endowments, or which are promoted by commercial enterprise, were, under the direction of a Commission, to give preliminary instruction in science?—Yes, if there were graded schools in science, just as there will be graded schools in classics, as I hope, upon the recommendation of the Schools' Inquiry Commission; I think we should have what we want.

1783. You have, I think, rather positively expressed your own personal opinion that any previous education to the hand or the eye in a workshop prior to scientific instruction is not necessary?—Prior to purely scientific instruction, I think not. I think that the hand and the eye want educating before the special technical course is taken, but not before a man learns mathematics and natural philosophy.

1784. I wish to give you an opportunity of explaining something which you said in reference to the largest amount of production of wealth, that you thought that it was important that the foremen and masters should receive scientific education and technical education, but that the mechanics might remain mere skilled machines, without such instruction; will you permit me to remind you that the inventions of many departments of industry in England have been the inventions of mere operatives?—I doubt their being the inventions of mere operatives; the inventions of the foremen they are very largely.

1785. Let me remind you that in Lancashire there is scarcely a machine, excepting the power loom, which has not been the invention of operatives?—So far as the inventive faculty goes, no doubt general education would improve the chance of invention.

1786. May you not have yourself met self-educated men who have been inventors, who have most painfully expressed to you their sense of the enormous difficulties which they have encountered in their own training?—My own experience has been diametrically the opposite of what you tell me in connexion with the spinning, but I assume that it is so; I have never met with a poor inventor yet, and this is to my mind a reason for educating the workmen.

1787. Take it for granted that as respects the textile manufactures, we are to a very large extent indebted to the inventions of uninstructed operatives, is it not obvious that their chances of contributing inventions would be greatly improved by better education?—Yes; they would be greatly improved and especially by the education in drawing which I recommend. I quite admit that, and of all men, wish to see the workmen better educated.

The witness withdrew.

Adjourned to Friday next at 11 o'clock.

*Professor  
F. Jerkin,  
F.R.S.*

28 June 1870.



No. 6, Old Palace Yard, Westminster, Friday, 1st July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

WILLIAM RICHARDSON, Esq., examined.

W. Richardson,  
Esq.

1 July 1870.

1788. (*Chairman.*) Are you a partner in the machine manufactory of Messrs. Platt, Brothers, and Company, of Oldham?—Yes.

1789. Is that a very large establishment?—Yes, very.

1790. In your own department, how many persons are employed?—2,000.

1791. Are many of them young men?—About 250 under 21 years of age.

1792. I believe you yourself began life as an artisan?—Yes, I did.

1793. Had you any special advantage of elementary day school instruction?—Very little indeed.

1794. How did you gain your education?—After I became a man; by study after my daily work.

1795. What educational institutions are there in Oldham?—The principal institution is called the Lyceum, and we have a number of Mechanics' Institutions as well, and private day-schools; and we have a national school and six church schools. Oldham is an extensive township, consequently there are a great many young persons to be accommodated in the different districts.

1796. Can you tell the Commission a little more about the Lyceum; what is the age of the lads or young men for whom the Lyceum is intended?—There are elementary schools in connexion with the Lyceum, as well as the science schools, and they begin with very small boys.

1797. Does the Lyceum embrace a number of schools?—Yes; it embraces a number of schools, both day and evening.

1798. Is the Lyceum all under one management?—Under a Board of Directors. There is one superintendent, and a number of masters: the superintendent keeps all the organization right; he is also the librarian, and has a servant or two to help him, besides the masters. We have a science master, two art masters, a mathematical master, and a number of elementary teachers.

1799. Do I understand you that, included in the Lyceum, are quite elementary day schools?—Yes, elementary day schools are included in the Lyceum.

1800. And those who have gone through the elementary day schools have opportunities of attending the more advanced classes?—Yes.

1801. You have also a school of science and art, have you not?—Yes.

1802. What are the subjects that are taught in the science department of that school?—In the art school freehand drawing is taught by two masters. In the science school we have mechanics, geometry, both plane and solid, applied mechanics, theoretical mechanics, machine drawing, and drawing for building construction. All the subjects are under the Department. We have not succeeded in maintaining a chemistry class; we have tried twice, and are going to try again.

1803. Have you a large number attending the mechanical drawing class?—There are from 50 to 60 on the roll, and about 25 to 30 regular attendants who go through the examinations.

1804. Have you any difficulty in securing a good teacher for that department?—The way we got our present teacher was by applying to Professor Rankine,

of Glasgow, to find us a good student. The first teacher we advertised for in the public papers, and we gave him 120*l.* as a certainty, besides what he got from fees. Mr. Platt subscribed that sum from his private purse, and as the school got more advanced that stipulation was reduced to 100*l.* The present master has 100*l.* fixed salary, besides what he gets from payment by results, and from middle class students.

1805. You have made inquiries, have you not, from some of the masters of the Lyceum and of the Science schools, as to what class of young persons make most progress in those schools?—Yes.

1806. Will you be so good as to furnish the Commission with their answers?—The answers are, "Those who have received the best elementary education; together with those who attend the most regularly; and give most attention to their subjects; continuing to attend the classes regularly from year to year; and do not study more than two subjects at once, besides practice in freehand drawing: joining the schools while they are young. Those who have the best teachers: and have the best text-books to study from; and who have a knowledge of mathematics: and receive proper encouragement. It is recommended that in order to assist the all-important elementary education, science teachers might instruct in the day-schools in some of the more elementary parts of their subjects; so that some artisans may be taught near their homes while they are too young to travel to science schools at greater distances than the day schools. They would know something of the subjects taught, and by commencing in this way before they begin to work they will be more ready to join science classes proper afterwards. The serious want of elementary education often debars artisans from ever reaching the standard that may be attained by those who have had a sound elementary education. The rudiments of Euclid, algebra, and trigonometry should be taught in elementary schools, in order to assist in the more advanced parts taught in the science schools, and to train the reasoning powers of the mind."

1807. Have arrangements been made in the elementary schools for giving instruction in algebra and Euclid?—We have a mathematical teacher in connexion with our elementary schools who does give instruction to the scholars. He is engaged to give the scholars instruction in mathematics and Euclid before they go to the science schools, and those who have gone to the science schools before they have had elementary education also go to elementary classes afterwards.

1808. Have you also asked whether the young men who attend those schools make more intelligent artisans than those who do not attend?—Yes, and the reply I have got is, "Certainly they do." "A marked improvement is noticed in them by their making more steady workmen; being generally healthy, through having their time well employed in their evenings; making them more trustworthy, and not requiring so much looking after by the managers. They can more readily understand new matter in connexion with their work; and being more willing to be in-



“ instructed, learn more readily, and so more quickly  
“ become skilled workmen ; and they are able to direct  
“ others better, and explain their meaning in more  
“ direct terms. They are more willing to teach others,  
“ and work together with more unity. They can often  
“ foresee errors, and probable results ; they can adapt  
“ their knowledge to new ideas, and work out their  
“ own ideas with more economy of materials and  
“ time.”

1809. Can you also furnish the Commission with the results of your own experience in this subject?—Boys that have not had a proper elementary training before joining the science schools make much better artizans than those of the same class who do not attend those schools. They understand a drawing when they see it, and can transfer the design to the material they are engaged upon much better than those who have not learnt to draw. There is another matter which is very important, and although it is going a little bit off the subject, I think it is necessary that I should give it to the Commission, because it really relates to boys without education. Those boys that are to be employed in trades where the labour is of a nature that tires the body and limbs and sullies the hands and clothes, and requires the muscles to be trained to the use of the tools to be employed in such trade, must commence work while they are young—say from 13 to 14 years of age—or it will be difficult to get them to take kindly to such work if much older before they commence. The elementary school training should be arranged so as to be accomplished before those boys arrive at the above age ; such boys to continue their studies in the night schools. To encourage those boys it should be made very easy to get a prize in the elementary stage, as encouragement in the shape of prizes is most needed at the outset of the student's career. The prizes should be given to those students who stick to a subject till they thoroughly understand it, instead of encouraging them to learn a number of subjects partially. The Whitworth prizes are a great encouragement to the students in the higher branches. If such prizes were more numerous, those students who passed in all the subjects that are required for those scholarships could have an opportunity to pass a course of study in such institutions as Owens College, in Manchester, this would be a good method of providing science teachers as well as a better class of foremen for engineering works.

1810. Have you made inquiries of the teachers of the science schools as to their views of the best mode of making them more efficient?—I have, and the following are their views :—“ By making science teaching a profession ; and a science teacher being wholly occupied by science teaching, and preparing the matter which he teaches ; with a remuneration such that a teacher may hold his proper position in the social scale, and have a gentlemanly living : being paid under three heads ; first, a fixed minimum salary, but which shall be increased for an increase above a minimum number of artizan students, all artizans to attend a minimum number of lessons, otherwise not to be considered as students. Secondly, an additional salary for attendance, in the cases of artizans attending three-fourths of a maximum number of lessons. And, thirdly, a further salary for artizans who pass in examinations held by the Department : the scale of salary not being changed during the then current session. By the teacher being trained for a science teacher in a college or university ; and having some practical knowledge of his subjects, for example, having worked a short time in an engineering establishment : the pay and position being made such as to induce parents to send their sons to a college or university in order to study for science teachers. By giving the teachers scholarships and fellowships, so that they may be encouraged to prepare in the higher branches of the sciences, and good men be training for college and university professors. The teachers being encouraged to send to the Department an

“ account of the system which they find to work  
“ best for teaching a science subject ; and encouraging  
“ teachers to write books, make drawings, and bring  
“ forward new matter :—paying more than one  
“ teacher in the same subject in the same school,  
“ where the number of artizans is so great as to  
“ require more than one teacher :—20 being considered  
“ the minimum number of artizan students to constitute a school. Artizan students not taking more than two subjects in one session, besides free-hand drawing ; by the artisans being supplied with good mathematical drawing instruments, enabling them to make better work, and have more pleasure in their work—they might pay for the instruments by weekly instalments. By the department prescribing in the syllabus the divisions of a science subject, each division to be taken by students in progressive years, so as to extend over a greater length of time than at present, each division to be subdivided into several parts, the student being examined in one division each year and the examination questions being deduced from these subdivisions only ; a set of text-books being supplied to the schools for the study of the prescribed subdivisions, thus making the study of a subject more thorough than at present. The syllabus being published directly after the examinations would assist students to know what to study at home, and partly obviate their difficulty of having to work and reason on totally new matter when at school, and would enable students to remember a subject better.”

1811. Are the science teachers in your school of science also engaged in other employment for the most part?—No.

1812. That is their only occupation?—Yes.

1813. As a general rule, do you provide all of them with fixed minimum salaries?—We have two minimum salaries. We promised, when engaging the masters, that if their income did not reach a certain sum that we would make it up to that sum ; but there are only two cases, I believe, where we have had to do that, the mathematical teacher and the science teacher, each of them is engaged upon the understanding that he will have this amount, and if he does not make a given sum the committee will make it up to that sum for him.

1814. Have you any suggestion to offer from those teachers as to expedients for making the schools more attractive to artizans?—Yes ; they say :—“ By the Department giving the artizans more encouragement than is done at present ; as by giving them certificates of merit if they pass in examination, and certificates for good attendance, certificates being a valuable possession for an artizan, and a useful aid to an employer in judging of an artizan's merits ; more valuable books being given as prizes, so that artizans may be more aided in their future studies, prizes being given for success in examination, and also for attendance : each school holding an annual exhibition of the work done during the session, and prizes given ; returning the fees to those artizans who take prizes, and making the fees as low as possible. By endeavouring to make the schools so attractive as to make artizans feel a desire to come to the classes ; encouraging them to continue in their studies, so that they do not merely attend a lot of lessons at first, and then discontinue their study altogether :—holding classes in the summer months, enabling the preparation for higher questions in the winter sessions ; their being encouraged to study in the art classes so as to know more of the great value of free-hand drawing in the constructive and other arts. By the Department supplying the school with a set of text-books on the subjects taught in accordance with the syllabus, so that the artizans may refer to the books ; these books to be replenished from year to year to correspond with the changes made in the syllabus ; the examination questions not being made so difficult as to dishearten the artizans, and to be in

W. Richardson,  
Esq.

1 July 1870.



W. Richardson,

Esq.

1 July 1870.

" accordance with the syllabus. Also furnishing  
 " small models of solids to assist in showing prac-  
 " tically their delineations by solid geometry; and  
 " apparatus exhibiting the more modern applications  
 " of mechanical motions than at present are supplied,  
 " with models of examples of machines, and  
 " building construction, so that drawings may be  
 " made from actual measurements, some of the  
 " models being made to a smaller scale than the  
 " natural size. By the first session that an artizan  
 " attends in the study of practical geometry being  
 " taken up by plane geometry together with mathe-  
 " matics; the study of solid geometry to come in the  
 " second session course. By appointing thoroughly  
 " competent teachers, both in education and system  
 " of teaching; retaining and giving more assistance  
 " to the present teachers who have a school of  
 " 20 or more artizans. By holding the examinations  
 " in practical geometry on Saturdays; the examinations  
 " to begin at 5 o'clock, when held on Saturdays.  
 " Is a great difficulty to boys who have to attend  
 " factory work, being taken into examination classes  
 " for two and three hours a night, for two and  
 " three nights together; it is too laborious work for  
 " them, and as long as Saturday afternoon in our  
 " part of the country is a holiday, those examinations  
 " could be taken on Saturday afternoons. That would  
 " give the boys more time, and keep up their vigour.  
 " The boys become exhausted with two or three  
 " nights examination, one after another."—"By the  
 " number of artizan students on the school register  
 " being divided into as many equal sets as there are  
 " members on the committee of the school, each  
 " member to take one division of students under his  
 " supervision to see that they attend regularly, the  
 " school committee keeping the class register of at-  
 " tendance, each member taking it alternately for a  
 " week. Thus the students would see that more  
 " interest is taken in them; that those present are  
 " noticed, and those absent being looked up by the  
 " committee supervisor."

1815. Has there been anything like a general com-  
 plaint of the questions put by the examiners being too  
 difficult?—There has. The order was that to gain  
 a prize they must answer a number of questions in  
 both plane and solid geometry; one subject would not  
 take any prize. Artizan boys without elementary  
 training, and many of those that come to study, cannot  
 get sufficient knowledge to answer in both plane and  
 solid geometry in one session, consequently they get  
 nothing, though they may do something that is worthy  
 of notice, thus they get discouraged and will not  
 continue their studies. In the first stages they want  
 a very great deal of encouragement. As a rule boys  
 do not like brain work, and if they do not get some  
 encouragement and assistance they do not continue it.  
 That is the great difficulty, and I think it is better to  
 give a prize too much rather than one too little, espe-  
 cially for the first stage; if a boy has been a length of  
 time and made little progress there should be some  
 notice taken of it, but if he has done work he should  
 be encouraged by a prize, or certificate, or some mark  
 to give him a hope to continue.

1816. It is the opinion of the teachers that the  
 prizes are a very good mode of encouraging the pu-  
 pils?—Yes, certificates are a very good method; they  
 are a sort of certificate of character to a boy; if a boy  
 goes to a master and wants to get a situation he takes the  
 certificate with him, because it shows that he has had  
 some good conduct, and has done something to gain it,  
 or he would not have it; an employer would take a  
 boy of that sort sooner than he would take a boy  
 without one.

1817. Do the members of the committee, as a rule,  
 give much personal attention to the schools?—A  
 number of them do, but not the whole of them; I  
 suggest myself that they should all do.

1818. Do you think that that suggestion might be  
 carried into effect; could you find persons willing to  
 give so much time?—I think we might. We have a  
 number of them that take a great deal of interest in

it, but not the whole of them; but it is a very im-  
 portant matter, and if the employers of the boys were  
 to go to the school and see who attended, it would be  
 most advantageous. There is another plan that I find  
 very good. In works like our own, where we have a  
 number of branches of trade, a boy wants to shift  
 when he has been at one business awhile, it becomes  
 monotonous, and if he has any ambition in him, he  
 wants to shift to another, and we arrange it in this  
 way, by saying to a number of boys in our place;—  
 "You bring me your drawings, and bring me your  
 work that you have done at the science school, and  
 the boy that has done the best work and got the  
 best drawing, shall be shifted first." That is a  
 great encouragement, and if all works carried out an  
 idea of that sort, the boys would be more enticed to  
 pursue their studies.

1819. Have you had any opportunity of ascertain-  
 ing the opinions of the best teachers of elementary  
 schools in Oldham as to the most likely mode of  
 introducing instruction in the rudiments of science  
 into those schools?—I have. We have a number of  
 schools in the place that they send the boys to; in  
 fact, I called all the masters together in the neigh-  
 bourhood of our institution when I got notice to come  
 here, and we had an evening's discussion on the  
 matter to get all their views, and they are mostly  
 embodied in those answers which I have read to the  
 Commission.

1820. (*Mr. Samuelson.*) You say that you think  
 it would be desirable for employers to make the pro-  
 motion of boys depend upon the assiduity of their  
 attendance at the science schools?—Yes, and their  
 progress.

1821. You would do that for the sake of the boys;  
 but do you think that the employers also would find  
 it to be their interest to pursue that course?—De-  
 cidedly. I think that it is the employers' interest to  
 have the best men in each department that he can  
 get, and I do not know of any better way of selecting  
 them than by the results of their own study.

1822. In practice in your own works, have you  
 been in the habit of making a selection upon that  
 principle?—Yes.

1823. Your science classes have now been in exist-  
 ence for some time, have they not?—They have been  
 working now pretty well for seven years.

1824. So that the boys who have been trained there  
 have also had an opportunity of acquiring practical  
 knowledge in your works and elsewhere?—We have  
 a number of those boys now that are leading men in  
 our works—draughtsmen and foremen—that have re-  
 ceived their principal scientific education in those  
 schools.

1825. And have you found it worth your while  
 commercially to give a preference to those men?—  
 Decidedly. We tried the schools in a small way in  
 the first instance, and we were so satisfied with them  
 that Mr. Platt built the schools himself, and gave  
 them to the town to make them quite universal, so  
 that all the children in the town are quite free to go  
 to them, he being quite satisfied that it would be a  
 good commercial speculation as well as beneficial to  
 the town.

1826. Before those schools existed, had you much  
 difficulty in finding suitable men as heads of depart-  
 ments?—Our draughtsmen principally came from  
 Sweden or from Switzerland, or some of the con-  
 tinental states, who had had instruction in the Poly-  
 technic Schools. We manage to do that with our  
 own men now, with the boys that we have trained  
 ourselves.

1827. As regards the men who are engaged more  
 in the superintendence of the works than in design-  
 ing, do you find there also the value of scientific  
 training?—No doubt; we cannot do very well with-  
 out. We cannot design machines, or construct them,  
 without some scientific knowledge.

1828. But I am speaking rather of the foremen of  
 your machine shops and in your forges?—A man that  
 can take orders and make sketches, and when he goes



away from the place seeking information, except he has got an aptitude for sketching and drawing, he is of little use or no use at all in the matter. We must have intelligence, whether they have acquired it themselves after they have grown up, or however they get it, they must have it. A man cannot go out to mills and take the dimensions for machinery, shafting, and take plans of rooms, and lay out machinery unless he has got some knowledge of drawing and mathematics.

1829. I believe you are in the habit of sending mechanics abroad for the purpose of erecting the machinery which is constructed in your works?—Yes, we are.

1830. Do you prefer to employ men who have been educated in those schools for that purpose?—As to the men that go out to those jobs the school has not been sufficiently long established to have much effect upon them. We have had to send out a few of them to such a place as India, where we cannot send aged persons, and where young men must go on account of the climate; then the young men that have the best elementary education, and can write the best letters, and understand the business best, are selected; for those other men when they get a distance away from home cannot hold technical correspondence, and they often lose themselves and cannot call our aid to them.

1831. And therefore you prefer those men who are so trained?—We must have young men who have had both a good technical and a good commercial education too.

1832. Apart from the knowledge that they acquire, do you find that their social habits are improved by this training?—Yes, a great deal. You will find in works, at least we find in works like ours, that when a man has had no education at all he fills up his time either by betting or racing, or some nonsense or other; that he will study and work very hard for three or four months, but as soon as the race is run the whole of his study is lost, and he begins a fresh study; and not only is it of no use to him, but it is a very great hindrance, because he is always thinking about the races that are going to be run, and he neglects one half of what he should do. A boy that has been to the science school is taken up with reading, and books, and study, and he thinks about his business, and very seldom does he make a blunder. We find it of very great value indeed to get a boy to become a bookworm, as it were, sooner than he should become a sporting man.

1833. You have stated that it was desirable that the committees should exercise some supervision over the attendance at those schools; have you found that persons in Oldham are willing to devote themselves to such superintendence?—I can speak for myself, and one or two more that we have in our works, that we never miss a week without going to some of the classes, and sometimes two and three times a week to see who has attended; and we tell the master that if any boys under our supervision do not attend properly we will come on a certain night and see if they are absent, and will inquire the reason why they are absent, and by that means we get a better attendance. The boys that are willing to go to a school, and have not the means to go, we very often pay for ourselves out of our own pockets. We generally have half a dozen boys in the school who cannot afford to pay their subscriptions, and we pay for them.

1834. Do you think that the boys are really thankful for that superintendence, and do not consider it a nuisance?—Decidedly.

1835. I think that you have lately been on the continent for some time?—I have not been on the continent any length of time in my life. I have been on the continent several times, but never to stop any length of time. I was on the continent only about a month ago.

1836. What parts did you visit?—As far as the School of Science goes, I was at Aix-la-Chapelle, and I went through the new Polytechnic Institution there. I have not been to Zurich, my intention was to have gone to Zurich and to see the school there, but I

was called home urgently, so that I did not have the pleasure of seeing it, but I was very much pleased with the one that I saw at Aix-la-Chapelle.

1837. Is that a school of high grade, or does it more resemble our science schools?—It is very much higher than anything we have here that I have seen.

1838. What are the ages of the students there?—That school is only quite new; the first session has not commenced yet. I merely went through the establishment; they were not studying. The session is not on, but all the machinery is there that is to be used when they do open. The place is quite new, consequently it is looking very well just now.

1839. Did you ascertain in what way that school was created?—I understand that the district and the town and the country and private individuals have all subscribed their mites towards it; it has not come from any one source.

1840. The contributions have been made from private sources, and also from the locality?—Yes, from the locality, and from the Government as well.

1841. That is to say, a public subscription from the locality?—Yes, a public subscription from the locality, as well as a corporate subscription; a private and public subscription, a corporate subscription from the district, and a national subscription from the Government.

1842. Have you come much into contact with the foreign artisans abroad?—Yes; those that we have had as draughtsmen in our own establishment have all studied in those schools.

1843. Have you seen any of the factories for the construction of machinery similar to yours that are now established abroad?—No.

1844. But you come into competition with their products?—Yes.

1845. Have you noticed whether there has been any advance lately in the excellence of the machinery which is constructed abroad?—We find their ideas coming into our patent office; and we have a very good knowledge of what they are doing, because they can scarcely contrive anything of that kind but what they bring it into our patent office, and we see there what kind of contrivances they are. I do not think, as far as practice goes, that they are able to hold their own with us; but so far as education goes they are far superior to us.

1846. But do you think that they are improving in practice?—There is no question about it, and very fast too.

1847. We are not so far ahead of them, are we, as we were 10 years ago?—Nothing like it.

1848. And do you attribute that in part to their superior theoretical education?—There can be no doubt at all about it that they understand the first principles, as a body, better than we do, and consequently they know how to carry them out. A little more than 12 months ago I was at Augsburg, and you know that is quite a manufacturing place. I got an invitation one night to meet the managers of the different mills at a club. They have a sort of club there; and instead of having the jealous system that we have in this country it is quite the contrary there. If a manufacturer here gets a little bit of an idea which he thinks he has five minutes before his neighbour, he locks it up and will not let anybody see it; but there all the managers and different people that conduct works have a sort of club, and they meet together, and if one man has got anything that he thinks a little better than another it is discussed by the club, and there are no secrets among them. Everyone tries to make everyone as clever as they all are; and I think from that circumstance alone they must have passed through an examination in a technical school. There is no man scarcely gets a manager's situation on the continent now who has not passed the polytechnic training; and the consequence is, that by that method no doubt they will in time, if we do not step out, equal us, and I should say pass us too, and I do not see why they should not if we keep neglecting our duty as we have done.

W. Richardson,  
Esq.

1 July 1870.



W. Richardson,  
Esq.  
1 July 1870.

1849. Are they in the habit of exchanging ideas with reference to improvements?—Yes, with regard to their own technical trades.

1850. Would you consider it useful or not that youths should be able to obtain information of that character in technical classes?—I do not see any harm at all in giving a youth as much information as he has capacity to carry. Brains are not all made alike, and we shall always have a great many heads that will not carry very much more than what will enable them to do common work. But all the good capacities that nature gives us we ought to cultivate to the very best of our ability, and get the best men from wherever he comes, even though he is out of the poorest class; if he will make the biggest man we have got, we ought to encourage him, and make him into the biggest man.

1851. Supposing a young man to be an apprentice, or what is the equivalent of an apprentice in your factory, in which you construct chiefly cotton machinery, would it not be of great value to him even in constructing cotton machinery if he had a theoretical knowledge of flax machinery, for instance?—If he gets a theoretical knowledge and what we call book learning, he will very soon adapt his mind to any kind of machinery, either flax or wool, or anything else. Three-fourths of all the information required, he gets in school. As to technical practice, his reason will soon lead him into it. The only thing is, if you have got a laborious business, you must commence when the boy is young. If you let a boy stick at school till he is 16 years of age, he will want to get his living by driving a pen; and if he gets hold of something that will make his shoulders ache, and strain his arms, he will want to lie down; but if you use him to do it before he knows anything else, he will never feel any hardship in it, and he will continue to do it.

1852. Suppose a youth is engaged practically in the construction of cotton machinery, would you consider it desirable that there should be some institution in which he should have an opportunity of acquiring a knowledge of flax machinery, and we will say, also of the construction of a steam engine?—I do not think that it is desirable to want to push these things too far. We find that the success of our country is from the classifying of trades. If he is to be really good at any one thing, if he is to be a really good cotton spinner, or if he is to be a really good machine maker, he has quite enough to occupy his time and attention if he is to be the best man in that business. The two manufactures never exist in the same district; and I say, in another district where the flax manufacture does exist, let them make the best men they can in that district; it is the same as learning too many trades that makes a man a jack of all trades, and master of none. I think we should learn to do rightly, and in the best manner possible, what we learn to do.

1853. You think that with the exception of rare instances, a youth has not time to learn all those things besides learning the principles which are common to all trades?—He has not time to become the best man in every one of them, and what we want is, to have the best man in each. It is desirable that every man who has anything to do with these manufactures should understand a steam engine, and should understand the properties and the use of steam; and if he is to be a leader in any mechanical works, he should understand the powers that are to drive those works.

1854. In your own case I believe that you erected works for manufacturing iron for the construction of your own machinery?—Yes.

1855. Can you state why you did so?—Because we could not buy the qualities that we wanted, and we could not get them as regularly as we wanted them, and so we made them.

1856. Then it would be an advantage to a person engaged in your particular branch of trade to have some knowledge of the manufacture of iron?—No doubt of it.

1857. How would you expect him to obtain that without going into ironworks?—I can only tell you this, that when our Mr. James Platt was living, he made up his mind that we should manufacture iron, and he came and gave me a commission to erect a forge and begin to manufacture iron. I had never taken notice of any forge in my life; but the only thing I had to do was to begin to acquire what it was necessary to know. I then managed to get sufficient knowledge to erect a forge under my own supervision, and I think I have been as successful as most people.

1858. If you had had some preliminary knowledge of it, would it not have saved you a great deal of trouble?—I knew good iron when I saw it, and that if I did not get it good I must try some means to get it.

1859. Is not that a rather expensive mode of getting knowledge?—I do think it is. It would have been much better if I had had the knowledge to begin with, no doubt, for I had to do my other work while I got it.

1860. (*Dr. Sharpey.*) What fees do the young men pay who attend the science schools?—About 2s. 6d. a quarter, or 10s. a year.

1861. Do they attend all the courses in the year for that fee?—Yes.

1862. What may the teachers of science make in the school altogether?—I think our last master that we had before this, when the examinations were not so strict as they are now, made about 200*l.*, with his minimum salary, prizes, and all together.

1863. I think you spoke of the importance of raising the social position of the teachers, and improving them generally?—Yes.

1864. Do you think that such an income as 200*l.* a year, even pretty well assured to a teacher, would be adequate as a maximum income?—No, it would not, because our teacher left us even when he was getting that; he would not stop with us. I do not think that any teacher who had got sufficient knowledge to do that business, would stop for that money. They will stop till they have made acquaintances and made a position, till some one will find out their worth, and take them away and give them more.

1865. There is a difficulty in keeping them?—Yes; if a man has sufficient knowledge to teach a school like ours properly, he should have a good deal more than that. People in commercial pursuits with the same knowledge get more, and consequently they verge off to those other pursuits if they do not get more than 200*l.* a year. I think we ought to keep them, if possible, and pay them as much as anybody else would pay them for anything else they could do, if they only had the same knowledge.

1866. Have you considered how that increased emolument might be obtained?—We have put down three ways for it. One is a minimum salary, another is an additional payment for attendances of the pupils. A man may do his best with his pupils, but of course he cannot make them all pass, and then the other plan is a further payment for results. We want a man to have an interest in both keeping the pupils at their study, and getting them to produce some results which belong to that study. Then the minimum salary is to get a man to venture on the speculation at all.

1867. How many nights a week is a teacher employed?—Five.

1868. Could not he make up a better income by attending two different establishments?—If an establishment is as large as ours, he has got more than he can do, he wants assistance rather than to have his attention taken away.

1869. (*Mr. Samuelson.*) Have you at all thought whether it would be desirable to let the science masters take pupil teachers?—The science master's students are in a manner pupil teachers; his students that have passed in the higher grades he takes to assist him.

1870. (*Professor Huxley.*) I think you said that you had to pay out of your own pocket for some of



the boys who attended the schools, would it not be very desirable that there should be no bar of that description to the attendance of any boy?—Decidedly, boys that are not able to pay if they wish to go to the school, ought to be able to go.

1871. Then I understand you would advocate a system of free schools?—I would.

1872. Do you think that it would be attended with any evils if such a school were established?—I think it is quite as well for boys that are able to pay to pay something. The boys that I have generally assisted myself have been orphan boys; boys who have lost their fathers. Sometimes a very worthy servant in your works dies and leaves a widow with a young family to bring up, and you have a feeling for those boys, and are glad to assist them. Those are the kind of instances in which we pay the school fees for them.

1873. Your great object is to use this system of schools and examinations to pick out the capacities from the mere hand workers?—Yes.

1874. Do you think that it would have a demoralizing effect upon the workmen if scientific instruction were absolutely free to anybody who chose to apply for it?—No, because if a boy applies for instruction after he has begun laborious work the difficulty is over. I think it would have a demoralizing effect upon the workmen if they were kept at school too long before being sent to work, if they were intended for hard labour. If a man is intended for hard labour or to use special tools, that require his body and muscles to grow into form to wield those tools, he should begin with them when he is young; but I think that the elementary education ought to be so readily and effectively given that when a boy has got some elementary knowledge, and is big enough to begin to use his tools, he shall have a desire to continue his study afterwards.

1875. The purpose of my question was rather to ask whether you thought that the offering of scientific instruction without payment to the children of all operatives would have any demoralizing effect upon the operatives themselves?—I have not seen any case where I think it would have any demoralizing effect.

1876. Do you think that such instruction as could be obtained in a chemical or metallurgical laboratory would be of use to a person subsequently to be employed in ironworks, for example?—Yes, in any works that I know of.

1877. Do you think that it would be useful to a man who had seen such operations, although he might not actually have been put in acquaintance with a blast furnace?—It is decidedly a great advantage for a man to understand the bodies of all the materials that he comes in contact with, and I do not see how he can be acquainted with the bodies of the materials that he comes in contact with, unless he has got some chemical knowledge, and that he should quite understand the fuels, and the way to burn them, and a great many things which a good chemical knowledge would be very useful indeed for.

1878. So that, suppose metallurgical teaching and a laboratory were set up in Oldham, we will say, do you think it would be a benefit to your ironworkers if they were sent to pass through that metallurgical laboratory?—It would take some time, no doubt, to get them through it, but it would be a very great benefit to them, supposing they would go. Men in forges, and foundries, and those places are rather a rough class of humanity; it is a laborious business that they go through and there are but few of them, and it is very difficult indeed to find a very intelligent man to conduct like establishments to those, and a good many are taken in when they are very young, and those boys that have good capacities if they were encouraged to go to a school of that kind after they had got accustomed to the laborious part of the work would never fear going to it again, even if they did get superior knowledge, they would become better conductors of such establishments.

1879. I apprehend that when Mr. Platt came to you and desired you to set up an iron forge he knew quite

well that you already had some considerable acquaintance with chemical matters?—He knew that he had never set me to do anything that I had not done, and he had faith that I should do that too.

1880. Supposing that you had been able to pass through such a course as the metallurgical course of the School of Mines, do you conceive that that would have been of much use to you?—It would have saved me a great deal of useless labour.

1881. You were speaking of the desirableness of setting boys who were to be employed in laborious trades to their work very early; do you find in your experience that such boys have much mental energy at their disposal after the day's work is over?—Yes, we do.

1882. Sufficient to carry on their instruction, in fact?—Yes; the little I have got was after 12 hours work. We had not the 10 hours Act in my youth. I had to commence at 13 hours a day when I was 11 years old. We then had the benefit of the Short Time Act to reduce it to 12, and then after I became a man we had another Act which brought it down to 10 hours, so that through the whole of my training from 11 years old, I worked 13 hours a day.

1883. After working that number of hours did you go to your book work, if I may so inquire?—I was too young then. I was only 11 years of age then. When we got the 12 hours Act I was 14 or 15 years of age, and then I did not do much book work. In fact I could scarcely read a handbill on the wall till I was 19.

1884. But you think that supposing a boy had not more than 10 hours' work, actual practical hard muscular work, there would be a sufficient balance of energy left for him to take, say, two or three hours instruction in the evening?—Two hours is quite enough.

1885. Would that observation apply to average boys, because we must not expect every boy to have quite your share of energy?—I say that you will not make every boy grow up into an intelligent man whatever you do, because it is not their nature. One boy would rather be satisfied to learn one thing and stick to it the whole of his life. Then you find another boy that you cannot keep to one thing whatever you do, or whatever you give him.

1886. But you would feel that instead of being exhausted with work he would be able after 10 hours work to employ two hours instruction with profit?—Decidedly. We should get quite enough capacity in that time to conduct our establishments in a proper and effective way.

1887. (*Sir J. Kay-Shuttleworth.*) I understand from you that you have several elementary schools and mechanics' institutions besides the Lyceum and the School of Science in Oldham?—We have.

1888. And that those elementary schools have been going on for many years, but up to a very recent period you have found boys, until they had the advantage of the evening classes of the Lyceum and the school of science and art, very imperfectly educated?—Very indeed.

1889. So that so long as there has been that exceeding imperfection of their education, you observed that the boys who have received sufficient instruction in reading, writing, and arithmetic, prefer the occupation of clerks, and other similar pursuits, to the grimy pursuits of the forge, and the mechanic's shop?—Decidedly. If they get to an age of more than 14 or 15 years you cannot get them into the dirty trades, they will not go in at all. Hitherto there has been quite enough of situations as clerks for all the boys that have sufficient education to take the situations, that is, if all boys had a good elementary education, some of them would be obliged to go to the works, but up to the present time they have all found quite sufficient work at driving the pen and such like light jobs.

1890. I understood you likewise to say that the education of the hand and the eye in mechanical trades is of the very highest importance to produce

W. Richardson,  
Esq.

1 July 1870.



W. Richardson,  
Esq.  
1 July 1870.

the most skilled workmen?—Decidedly. If a man can go into a smith's shop and can get a piece of chalk in his hand and can go to a black board and draw off-hand when he only wants one thing, certainly it is not worth while to go into the drawing-room and get a fresh drawing of it, and if he can go and get a piece of chalk and put the thing on to a black board in a moment, so that the smith can understand what he is doing, the smith will have the thing done before the draughtsman would have it on paper.

1891. I likewise understood you to say, that if that education of the eye were combined with freehand drawing from models, such as can be obtained in your school of art, the combination of that practical work with the instruction in drawing, would greatly increase the value of the workmen in your works?—Very much indeed.

1892. Will you kindly further explain how that would operate?—Supposing a workman goes out into a factory, and he sees something in a machine that the master wishes to have put upon his machine, if the man is a good freehand drawer and a good lineal drawer, he can pull his pocket-book out and take his pencil and run off a general idea of it on a leaf of his pocket-book. That will do a great deal more than if he wrote two or three pages in his book to the man who had to execute it.

1893. Supposing a man to be going through any works, and that he saw that an advantage might be gained by some mechanical combination, if he had a knowledge of freehand drawing from models, would he not be able to sketch it at once?—It is important in the way I have just been explaining to you, because he brings the idea home with him; if he cannot demonstrate it by language he demonstrates it by his hand, and the parties that have to execute it seize it at once, and whilst another man is taking time to write a description of it, the first has done it and carried it into execution.

1894. So likewise, in the case of the young men whom you have to send to every part of the world to set up machinery, as you say, if they get into any difficulty, is it not extremely important that they should be able to explain that difficulty in this way, and to convey it to the firm at home?—Yes, it is; it can come home in a letter. A very remarkable instance of that talent, which I was very much pleased with one day, I saw at the Bridgewater Foundry, Patricroft: James Nasmyth, who used to be the principal of that establishment, was a very superior sketcher, and to go through his letter-book and see the sketches that he put into the letters he sent to the different people with whom he was in trade, is a treat to any mechanic. He would give a sketch by a few touches with his pen, and make the subject quite plain, and he would say: "Will you have it this way, or will you have it that way?" whereas if he had to write it, so as to make a person understand what it was, it would have taken a great deal of writing for both of them, so that his correspondent had only to say I will have the first or the second plan.

1895. I think I understood you to say that this education of the hand and the eye should be got in the workshop as well as in the drawing school?—The freehand drawing school I think is the proper place to get it, because there you get the acknowledged best methods of doing it. A boy learns to use his pencil in the proper way, and he learns the principles of his art as they have been established by people who have lived before him. It is much better to give those principles to boys, and not for them to have to study them out for themselves.

1896. But I am also referring to the manual skill which you told us you thought could be only obtained at a very early period—that training of the muscles and of the eye to which you have alluded?—If a man begins too late, after a man has grown up, if you place him in a smith's shop and make him begin to use a hammer and to use the tools in a smith's shop,

the first thing that would happen would be that his muscles would all begin to swell and his hands would be inflamed, and he would fly away from the business and would not stick to it. In the same way if a smith has been poorly a length of time, or has been away from his work, his hand has got away from its usage, and when he comes back to it, the first week or so, he would have all this inflammation and pain, but he knows that it will go away, and he will stick to his work until it has gone away, but a new beginner would not stick to it.

1897. Should I rightly interpret your view therefore, that at first a boy should have a certain amount of good sound elementary instruction in a day-school, and then, that secondly, he should go into a mechanics' or other shop to acquire manual skill?—Yes.

1898. And then, thirdly, that after having acquired that manual skill he should superadd to it whatever instruction you now give, or any better instruction that you may hereafter give in your school of science and art?—I could explain that better by stating the course which I took with my own son. I put him to an elementary school till he was 13 years of age; I then took him into the workshop for 12 months, and made him work like other boys; then I sent him out to school again for another 12 months, and took him into the works again for 13 months, and then I sent him off to Zurich to the Polytechnic Institute, so that he could study there for some time, or for such time as I thought desirable.

1899. You have spoken of the present very imperfect preparation of youths by elementary education, and of the discouragement which they very easily meet with in attending the evening schools, and that you were desirous that there should be encouragement afforded to youths to induce them to continue their instruction notwithstanding their bad preparation?—Yes, I feel very strongly upon that point.

1900. Might not that encouragement be afforded from local sources, so far as the pupils are concerned?—It should be done near to their own homes while they are very young, because they will be disheartened if they have to walk three or four miles backward and forward to school after they have done a hard day's work, and study two hours. The first elementary science should be given in elementary schools near to the homes of the youths.

1901. What I meant was rather, might not the prizes, and other rewards, and the personal encouragement proceed from local sources, rather than from Government?—That is what I say. If the employers of labour and the superintendents of establishments would pay some attention to those schools, and form science committees themselves, and go to the classes in their turns, and see and encourage the boys, it would have a most beneficial effect upon the schools.

1902. Then as respects the teachers, what would you think of such a plan as this: supposing a youth attended during one session the evening classes, and was unable to get a prize, but passed an examination, of a preliminary kind, which might yield no pecuniary reward to the teacher, but when the youth in question went through a second elementary stage, and had got to a higher stage, might not the teacher be rewarded in a higher degree if the boy passed the lowest grade of instruction for which the teacher obtains remuneration from Government?—The way that is put in the paper is this, that the teacher shall be paid for the attendance of the boy in the first session, though he has not passed. If he has attended a certain number of nights, he shall have some pay for him. He shall likewise have some pay for his attending well in the second session, and have some more pay for a prize if he gets it in the second session.

1903. (Professor Huxley.) How would you prevent sham teaching. You are aware that in all pursuits there are some people who do not look to the thoroughness of their work, but only to what they get for it, and there is a certain tendency even among



teachers, who should be superior to that sort of thing, to merely cram the boys with an appearance of knowledge when they have none really, and so get them to pass an examination?—That has been a very great practice under the Department till this last year or two, and the way we tried to get over it was by getting a teacher of good personal character. For instance, we applied to Professor Rankine to send us a known, steady, industrious man and a known good student. We took the man through the recommendation of a gentleman in whom we had confidence that he would send us a proper person, and in that way we have not been deceived.

1904. (*Sir J. Kay Shuttleworth.*) Have you any knowledge of other teachers of science in your district who are not employed in the school of science and art, or any considerable mechanics' institution?—We have no teachers in our district except artizans, principally that have taken some prizes in our own school, and have gone and set up in their immediate neighbourhood at some of the other mechanics' institutions and got classes there, and they have just instructed them in the branches that they know themselves, and confined the class to the particular knowledge in which they have obtained a prize themselves. The knowledge in those small schools is not so general, they do not understand so many subjects generally, but they teach those that they do know, and they are very useful in giving instruction to the smaller boys, who would have a great distance to go to the principal schools, and then after the boys get beyond the capacity of that master to teach them, and get bigger and stronger, if they have got ambition they go to the other school, where they can get superior instruction.

1905. You regard them as useful in a preparatory stage before they enter the central school of science and art?—We have taken all that have come yet, but we want to have them a little better trained before they do come.

1906. (*Dr. Miller.*) How are your science teachers occupied during the day?—In the preparation of subjects for the evening.

1907. Then they have no means of increasing their income during the day?—No.

1908. I thought you said something about private pupils?—There are a few of them in the art school, they have some private pupils; some ladies go to learn to draw in the day time. In the mathematical school the mathematical master gets some private pupils, the sons of middle-class tradesmen, who want to improve their mathematical instruction, and he teaches in the elementary school as a mathematical master; but the science master is doing nothing else, only preparing his subjects. He has five nights a week to teach, and it is as much as he can do to prepare his subjects for those five nights.

1909. Has he no teaching whatever besides those five nights?—No; he has no other business. The science master is now going to try and establish chemical classes, which will give him more work still.

1910. What does he teach?—He is teaching now in branches of geometry and mechanics, but he has a diploma for chemistry too. He passed Glasgow College in a great number of subjects. We have not a sufficient class that we can pay a special chemical master; we are going to do what we can, and what is sufficient, until we can get a class to enable us to afford to pay a special professor.

1911. Is his whole energy taken up in teaching science for five evenings in the week?—He has got it all so clear that we think now he may spare a little time to take the chemical portion.

1912. You have a Lyceum; is this an establishment which has been founded by your own firm?—The science portion of it, but we do not keep it under our management, for we turned it over to the directors of the Lyceum; it is built on their ground, and adjoins their building, and one entrance does for both institutions.

1913. The Lyceum is an establishment which has existed in Oldham for some time, has it not?—Yes.

1914. How long?—It is 15 or 16 years since the new building was opened, but the Lyceum proper was established about 1836 or 1838.

1915. About how many boys who go into those schools, do you think, turn out in such a way as would encourage you to continue this instruction?—The success that we have had already, we consider is quite decided, but it is not equal to what we should like to attain.

1916. Supposing 100 boys go into the school, how many of those boys do you think would repay the trouble that is spent upon them?—Perhaps 10 per cent. of them.

1917. What becomes of the other 90?—They are better than they would have been if they had never gone at all.

1918. But they are not disqualified for their hard work?—Not a bit.

1919. And it does not make them discontented?—No, it makes them better. A boy that has got some book knowledge can make work a good deal easier. If a man understands mechanics, probably he will rig up a pair of small blocks before he will strain his shoulders by lifting a weight, but if he knows nothing about them, he will get hold of the weight and try to lift it by hand, but as soon as they get a little knowledge they apply that knowledge to save their muscles.

1920. (*Marquis of Lansdowne.*) As to freehand drawing to which you say you attach very great importance, what branch of your educational establishment at Oldham has charge of that; is it part of the school of science and art?—Yes.

1921. Are they fit to begin freehand drawing before they begin mechanical drawing, and plane and solid geometry?—All of them that have a taste for it go into it at any time, but there are not so many go into freehand drawing as go into the other. I should like to enforce it as a study.

1922. In fact, you consider it almost in some degree to replace writing instead of description; you think free hand drawing comes in better?—Much better than writing. You can describe a great many things with a pencil on paper, that you could not well make a person understand by writing.

1923. Therefore in that respect it is hardly on the footing of scientific education proper. It is almost prior to that, is it not?—We are making it necessary now. Sir Joseph Whitworth, in his scholarships, will not give a boy a scholarship, except he can draw freehand effectively.

1924. Have you any knowledge of the class of teachers at other manufacturing towns than Oldham in the district, where they are not, perhaps, so fortunate as they appear to be in Oldham, in having Messrs. Platt's factory there?—I think that Manchester, Bolton, Leeds, and Huddersfield, have made some considerable progress, and in fact a good many other towns.

1925. Do you find that those towns have suffered in respect of teachers from those difficulties which you have mentioned, that is to say, the remuneration and the position of the teachers being insufficient?—I cannot speak so pointedly about that, because I have not got the information.

1926. Your teachers at Oldham cost you a great deal more, probably, than they do at those other places?—No, I think Huddersfield, for example, is before us.

1927. How long do you say that the experiment of those science schools has been tried at Oldham?—About seven years.

1928. (*Chairman.*) I think you stated that you thought 200*l.* a year an insufficient amount of remuneration for a good science teacher?—It is for a man sufficiently clever for a school like ours.

1929. What do you think his remuneration ought to come up to?—I think 300*l.* at least.

1930. You recommend that those who are unable to pay should be admitted free; do you think that there

W. Richardson,  
Esq.

1 July 1870.



W. Richardson,  
Esq.  
1 July 1870.

is any difficulty in having at the same school the pupils who pay and the free pupils?—I see no jealousy of that sort in our schools, but of course they do not know who is paid for and who is not.

1931. You do not find any unwillingness to pay on the part of those who are able to pay?—No, I do not think there is any jealousy at all in that respect.

1932. Do you think that in certain great centres, like Manchester, higher schools of science, like Owens College, should be established in additional numbers?—Decidedly.

1933. You do not think that it would be advisable that your more advanced students should be obliged to go to London to continue their studies?—No; I think it would be more advisable if we had more schools like Owens College in all large towns. For instance, sup-

posing we have got an artizan who holds a tolerably good situation, say, in our establishment, and that the young man has acquired all the information he can get in our science school, when he wishes to get a higher grade of education than what he can obtain there, he has the great advantage of being able to go to Manchester for evening study, to take the evening course in Owens College; as he can be back home again the same night, he can continue his employment at the same time he is getting that instruction.

1934. Do any of your people go to Owens College?—Yes.

1935. That is only a few miles distant?—Manchester is about seven or eight miles from Oldham.

1936. I suppose there is pretty good railway communication and constant trains?—Yes.

The witness withdrew.

Mr.  
R. Applegarth.

MR. ROBERT APPLGARTH examined.

1937. (Chairman.) I believe you are the secretary of the Amalgamated Society of Carpenters?—Yes.

1938. Have you paid much attention to all questions affecting the interests and condition of working men, using the word "interest" in its largest sense?—I have.

1939. And workmen's education in science is one of the subjects to which your thoughts have been directed?—It is.

1940. What is your opinion with regard to the present educational arrangements for science, do they furnish sufficient facilities for the acquisition of scientific knowledge?—My opinion is that they do not.

1941. Can you point out the improvements which you would recommend to be introduced into elementary schools?—I think that it is very essential that elementary science should be taught in all primary schools.

1942. A certain amount of arithmetic, and in some cases algebra, is taught, is it not, in elementary schools?—Yes, but that is not sufficient.

1943. At what age do you think lads are capable of receiving with advantage instruction in elementary science?—Competent authorities tell us from eight years of age.

1944. What are the elements of science which you think should be taught in elementary schools?—Elementary geometry and mechanics; elementary chemistry and physical geography I think very essential.

1945. When they had acquired a certain amount of elementary knowledge in primary schools, how do you think that this instruction could be best continued?—They have a very admirable mode on the continent, of which Mr. Samuelson knows something, and about which we have had blue books without end. After grounding them well, as they do by a compulsory system of education on the continent, they have apprentice schools. I will read an extract from the French Report on Technical Education, page 8, which says with regard to Germany, "Among the obligations incumbent upon apprentices we nearly everywhere find that of attending from 16 to 18 years of age the lessons given on Sundays and holidays, and even in some cases evening classes, which are held at the primary schools. These lessons which are intended to improve the instruction which the young people have received, by giving it further development, are not only a very useful, but as we think an indispensable supplement of the studies of the primary schools." And you will find on page 69, that practical schools (Real Schulen) are "very numerous in Germany, where young men intended for trade and manufacturing houses receive a general education. In Prussia the courses comprise the German, English, and French languages, sometimes Italian and Latin, history, geography, the elements of natural history, physics, and chemistry, commercial arithmetic, elementary geometry, singing, and gymnastics. The schools are attended by a large number of pupils, all day scholars." These schools are divided into

higher and lower grades; in the lower grade "the instruction is so graduated that these schools can receive boys as early as seven or eight years of age, who can read, write, and calculate." I cannot see why something of the kind could not and should not be done in this country.

1946. Could you point out to the Commission the steps which you think should be taken to bring that about in this country?—First, we should have a compulsory system of primary education; and in the primary schools I think that the elements of science should be taught, such as I have indicated, and something more than I have mentioned might be introduced; and then I take it that before lads leave school, or just after they have completed their school age, which I for my part would fix at 14 and not at 12, I would have them undergo an examination, so that when an employer of labour took a lad as an apprentice he would take a lad with some knowledge of the science of the trade which he was going to learn, and if he had an inclination for one trade or another he might in the primary school receive some special training to fit him for that particular trade for which he had a desire. Then the employer having with the boy a certificate of his fitness to learn the trade that he desired to learn, it should then be incumbent upon the employer to teach the lad, or see that he was taught a scientific as well as a practical knowledge of the trade. That might be done in large firms, as I have suggested elsewhere, by trade schools being established in the firms, and where the industries are too small or too scattered, then the employers might combine together to do it.

1947. Do I rightly understand you to say that you think employers on a large scale ought to be bound to establish those schools?—Undoubtedly.

1948. Do you mean that they should be compelled by legislative enactment?—Yes.

1949. At present I presume employers, speaking generally, are not all capable of providing any scientific instruction for their apprentices, with a certain number of exceptions?—That is the case, and with certain few exceptions they have very little scientific knowledge of their own trade themselves.

1950. Have you paid much attention to the science classes which have been instituted under the Science and Art Department of the Privy Council?—Yes, I have paid some attention to them.

1951. Do you think that they are doing much good?—Yes, they are doing great good, but they are capable of doing a great deal more.

1952. What improvements do you recommend to be introduced into those classes?—I think the first essential is that the educational department should be consolidated. The Whitehall Department and the South Kensington Department, instead of working in harmony, appear to me to be causing a great deal of friction, and wasting a great deal of what might be useful effort. Having got them consolidated, they would be in a position to do a great deal of useful work.



1953. Have many young men made great progress with the aid of the science classes?—I do not know that I can say that they have made great progress. The difficulty has been the want of elementary education to begin with. Those who have walked through the different classes in different parts of the country, as I have done, have seen grown-up men attempting to master the simplest elements of science which as boys they ought to have known thoroughly, and very many have given up the attempt in despair for want of a sufficient amount of elementary knowledge, and that grounding of elementary science which they ought to have received as boys.

1954. Do they come to those science classes incapable of taking advantage of the teaching which they receive there?—Many of them do, and they utterly fail in the attempt.

1955. Will you tell us what the men are doing for themselves?—There has been for some time past a great desire on the part of the skilled artisans of the country (and I take my own trade, that of carpenters and joiners, as an example), to obtain a greater amount of knowledge of the science of the trade than they have got at the schools, and some of them have made an attempt to obtain this knowledge. Some time ago Professor Fleeming Jenkin sent a communication to myself, and asked if the men connected with our trades' union would not take up the question of technical education, and I would wish to put in here the letter which that gentleman wrote to me; it is in these terms:

“ 6 Duke St., Adelphi, London, W.C.

“ Sir, 19th December 1867.

“ The evidence which you gave before the Commissioners appointed to inquire into the organization and rules of trades' unions, leads me to believe that you would willingly consider any proposal made in the interest of the members of the union of which you are secretary. I therefore take the liberty of asking your opinion of a plan for technical education which has occurred to me as feasible, and presenting some special advantages. You will probably admit that the governing bodies of the unions should lose no opportunity of increasing the usefulness of their societies, especially in any direction in which they are likely to meet with the sympathy rather than the opposition of other classes of men. Such an opportunity, in my opinion, is offered by the proposal I now submit to you, that the unions should add to their other benefits, the technical education of members and of the sons of members. Having had some experience both of English and foreign workmen, I must confess that while the Englishman is generally superior in manual skill, he is generally inferior to his foreign competitors in technical education. By this I mean that in mensuration, in drawing, or the understanding of a complicated drawing, and in a knowledge of elementary geometry and mechanics, the Englishman is seldom proficient, and the information which the better men do possess is seldom sound. This defect is certainly not due to inferior intelligence, but confessedly to the want of any means of obtaining the desired education; occasional lectures at mechanics' institutes have done little to supply the want, and in this country, unless the men themselves take the work in hand, I despair of seeing any great improvement. The improvements in their condition which workmen have obtained have, at least in their opinion, been due to their own exertions, not to any benevolent interference from other classes, nor yet to any special legislation. If workmen wish for education in the matters I have named, I think they can procure it for themselves, and that the organization of the unions may be usefully employed for the purpose. I observe that for special objects, such as charity, the members, say of a special branch, are not unfrequently taxed, as it were, with a special rate, levied for the special purpose, independently of the general funds devoted to the general purposes. I should propose that where a branch is

sufficiently numerous to make the necessary rate small, they should levy annually a sum for the purpose of technical education; that the right of admission to the classes should be given freely to members and their sons, and that other young men should be admitted to the classes on payment of reasonable fees. You may probably object that the expense of this plan would preclude its adoption, but I believe the necessary expense would be very small; in all towns where large works exist, there live a considerable class of draughtsmen, generally poorly paid, and unoccupied in the evenings. Some of these men would gladly add 20*l.* or 10*l.* a year to their income, and many of them possess precisely the information workmen are deficient in. Distributed among a branch of 200 members 20*l.* per annum would amount to only 2*s.* per annum per member, no large sum, if for that really valuable instruction could be placed at their disposal. I believe that rooms could in most cases be had free of expense, granted by masters, by mechanics' institutes, or clergymen. The characters and abilities of draughtsmen are well known to workmen in each shop, and they would, therefore, be able to appoint really efficient men; the draughtsmen would, I believe, in many cases, be glad to obtain practical information from the workmen. You perceive that my plan is a purely voluntary one. Any branch is free to choose whether it wants any teaching, and if so, on what subjects, and to what extent. Each branch is free to appoint its own teachers, and to discontinue their payment at any time. Each member is free to use or neglect the classes. The only action I should propose on the part of the council would be that the plan should be explained and recommended for adoption in their circulars, while the number of classes and the attendances would of course appear in the reports. The only action which I think the Government could legitimately take would be to grant, on examination, certificates of fitness to men willing to undertake the tuition, and further, perhaps, to establish a system of inspection by which the efficiency of the teaching might be tested. I think, however, that each branch should in that case be at perfect liberty to employ a non-certificated master, and to decline inspection. I trust you will forgive my troubling you, but I apprehend that you will agree with me in thinking that it is the duty of the governing body of a trade union to take an interest in all matters affecting the welfare of the members, and that technical education does very greatly affect their welfare. I should be glad to hear your personal opinion of the plan, and if you should think well of it, I hope you will submit it to your council.

I remain, your obedient servant,

FLEEMING JENKIN, F.R.S.,

Professor of Civil Engineering,  
University College.

To that letter I will, if you will allow me, read my reply:

“ Amalgamated Society of Carpenters and Joiners,  
“ General Office, 8, Northumberland Street, Strand,  
“ Sir, London, January 2nd, 1868.

“ I am directed by the council of the above society, to forward you the following copy of a resolution passed by them in reference to your letter of the 19th ult.:—‘Resolved, that the thanks of this council be tendered to F. Jenkin, Esquire, for his proposal on technical education, the council promising to give the matter that serious consideration which its importance merits.’ For my own part I may add, that no proposal could be made in the interests of the working class, to which I could give such hearty support and concurrence as I could to a proposal for education; and technical education I know, too well, to be one of the greatest wants of the artisan class of this country; and that the machinery of the trades' unions may be adapted to supply that want (and that without in the slightest degree impairing their usefulness for trade purposes), I have long been convinced. I have not up to the present time been able to devote the attention to your plan that I could have desired, but so far as I have

Mr.  
R. Applegarth.  
1 July 1870.



Mr.  
R. Applegarth.  
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considered it, I can give it my approval; but in this matter, as in all others, the start is the greatest difficulty, and I think I could suggest a slight addition to your proposal whereby the society could be made to assist in the establishment of a school, as soon as a sufficient number were ready to form one. I should, therefore, be glad of an interview to talk the matter over with you at your convenience."

That led to an interview with Mr. Jenkin who attended our executive council, and the following resolutions are the result of his interview: "That the executive council having well considered the suggestions of Mr. Jenkin on the subject of technical education, most cordially approve them, and pledge themselves to facilitate the formation of classes in connexion with the branches of this society." "That to enable our members to give practical effect to the proposal, we suggest that a provisional committee be appointed to collect the names of those willing to attend, and when 30 or more names have been enrolled, a committee and officers to be appointed to conduct the affairs of the school." "That when a sufficient number have properly organised themselves and have decided that they are prepared to pay a quarterly subscription in advance, sufficient to meet room rent, salary of teacher, and such other expenses as may be necessary, the executive committee will then undertake to interest themselves to assist such members to obtain meeting rooms, and Professor Jenkin has kindly promised to assist the executive committee as far as possible to obtain competent teachers." Our council felt very warmly upon the matter, and they said that they were "so impressed with the importance of the undertaking, and of its value to the trade, that they had resolved to leave no means within their power untried to make its adoption general and successful; and in the event of any branch or branches conjointly, or any number of members, from 30 upwards, considering that a loan would enable them to start a school with greater chances of success, the executive committee will be prepared to entertain an application for a loan from the contingent fund, and be ready to grant such loan when satisfied that the money will be usefully applied."

1956. (Mr. Samuelson.) What was the date of those resolutions?—Professor Jenkin's letter was on the 19th of December 1867; the others followed quickly after in the month of January 1868. That was issued to the society in our monthly report, and I have brought a bound copy of these reports, which I will leave with the secretary. I have, for easy reference, cut out of the reports of the various meetings certain paragraphs which indicate the progress that has been made. In addition to the communications which appeared in our reports which were issued to our members, I took every opportunity by private correspondence to select the best of the workmen in our society, and urged them to start classes. A class was shortly afterwards started in Manchester. They issued a prospectus, and the Mayor of Manchester, Mr. Robert Neill, became their president, and amongst their vice-presidents there are the Reverend William Huntington, Mr. Jacob Bright, M.P., Mr. Cheetham, M.P., Mr. Ernest Jones, Alderman Heywood, and many other gentlemen, some of them connected I believe with Owens College, Manchester. They started a school, and it is carried on very successfully indeed. As soon as they got it into working order, they applied to the executive council of our society for a loan, and out of our trade union fund we lent them 15*l.* which enabled them to purchase instruments and defray the necessary expenses. I have here a number of documents which show the progress which the school has made (*delivering in the same*). You will see reference made to various deputations, one of which waited on the Mayor of Manchester, with a view to getting him to take the chair at the Town Hall; and they had a very important meeting at which Mr. Scott Russell was kind enough to attend,

and proposed a very complimentary resolution. The members then appointed a deputation to wait on the Master Builders' Association, with the view to get the builders to co-operate with them. What they have done in that direction I am not prepared to say, but I do not think that the masters have given the men in Manchester the hearty support which I think a movement of that kind entitled the men to expect or to receive. When the school had been in existence about 12 months, an important trade congress was held in Manchester, and our council instructed one of the promoters of that school to attend that congress, and read a paper, which paper I will put in, describing the progress which has been made by the school. Our object was to induce other trades to follow our example. The last document that I have I find is the balance sheet issued in December 1868, and I find that during the 12 months they had an average of 63 members per quarter, and an expenditure of 75*l.* 5*s.* 11*d.* We had a school started about the same time in Pimlico, and I have here documents which describe the progress that school has made, and the various efforts made by the men to form the school and extend it. They had a public meeting at which Earl Granville attended. Mr. Samuelson was ill, but he sent them a letter of encouragement, and that school has done very well.

1957. Are those adult schools?—Yes, all adult evenings schools. We have had several others started in different parts of London. I really cannot tell how many, but they are all on one principle; they are under the care of one science teacher, who appears to be a man that knows his work very well, and he has been very energetic in pushing the formation of those schools. I have lent them all the assistance I could, and the result is, that in the east, west, north, and south of London, we have science classes, and in different parts of the country also. We have one in Hull, one at Sunderland, one at Birmingham, and at different other places; documents in connexion with which I will put in. But the work that has been done by the London science classes is summed up pretty well in a leading article that was written in September 1869 in the *Sheffield Independent*, and the object of the writer of this article apparently is to induce trades' unions to follow our example in organizing science classes. The article in the *Sheffield Independent* is as follows:

"The RESULT of a remarkable EXPERIMENT in utilising TRADES' UNIONS."

"TECHNICAL EDUCATION.—Our columns to-day contain the results of a remarkable experiment in utilising trades' unions, and we have the more pleasure in drawing attention to it, because its high success has justified it, because it is sure to be acted upon widely, and because it cannot fail to be approved by men of all classes and opinions. We have heard much of technical education, and it has such an obvious value and is so necessary that many persons in various parts of the country have taken measures to promote it, and have prepared students for the examinations held by the Science Department and the Society of Arts. The Amalgamated Society of Carpenters and Joiners, whose able secretary, Mr. R. Applegarth, is an enthusiast in the cause of education, have taken up the matter. They have united their influence to induce young artisans to join classes conducted by Mr. W. Busbridge, of Plumstead, and we now see the result of their first year's efforts. The classes thus attended were in geometrical and machine drawing, and building construction, and the numbers of the successful competitors for Queen's prizes and certificates may thus be summarised:—

GEOMETRICAL DRAWING.—1st Year's Students.

First class, 40, of whom 20 were from the Amalgamated Society of Joiners and Carpenters.

Second class, 20, of whom 12 were of that society.

Third class, 17, of whom seven were of that society.

MACHINE DRAWING.—1st Year's Students.

First class, 37, of whom 12 were of the Carpenters and Joiners' Society.

Second class, 38, of whom 19 were of that society.

Third class, 38, of whom 17 were of that society.



## BUILDING CONSTRUCTION.—1st Year's Students.

First class, 18, of whom five were of the Carpenters and Joiners' Society.

Second class, 25, of whom eight were of that society.

Third class, 36, of whom 16 were of that society.

Here we have 116 successful students from one trades' union as the result of the first year's efforts. Classes were sustained by the union in Manchester, Bradford, and other towns, where they have not had the same opportunity as in London. The work is extending. This society is organizing other classes in London, and is pushing on the work in the country. It is a cardinal part of its policy to secure competent teachers. In Mr. Busbridge they have an instructor whose pupils during the last three years have obtained 450 prizes, including the Queen's gold and other medals. The terms are attractive. While the middle class students pay two guineas each, working class students pay for the whole course, one or all subjects, 5s.

Now, as this is not only a great and good beginning, but the seed of much future good, and that it may be the more fully understood, we shall trace it to its origin. At the end of 1867, when Mr. Applegarth had given his evidence before the Trades' Union Commission, Professor Jenkin, of University College, wrote to ask his opinion on a plan of technical education which had occurred to him. He suggested that the governing bodies of the unions might extend their usefulness in a way that would enlist sympathy rather than excite opposition. He pointed out the general deficiency of English workmen in technical education. They were seldom to be found proficient in mensuration, in drawing, or the understanding of a complicated drawing, and in the elements of geometry and mechanics. Such knowledge could only be obtained by systematic study in classes under competent teachers, and the organisation of the unions might be well used to promote the object. The idea of Professor Jenkin was that by means of a small education rate, the unions should acquire the right to send their members or sons freely to classes, the rooms for which might usually be obtained from employers or the managers of Sunday schools and others, free of expense. The students prepared in those classes to have the advantage, if they chose, of employing certificated masters, and going up for examination. The prizes available to stimulate effort are not inconsiderable. They include:—

1. Eighty exhibitions of 25l. each, offered by Mr. Whitworth, for competition in mathematics, mechanics, and drawing, tenable for one year.
2. The Whitworth scholarships of 100l. each, tenable for three years.
3. The exhibitions to the Royal School of Mines, 50l. each.
4. Science and Art scholarships, 10l. each per annum.
5. Elementary school scholarships, 5l. each per annum.
6. Four medals (gold, silver, bronze), to the best four in each subject.
7. Prizes consisting of books, microscopes, telescopes, and drawing instruments, given to all who pass first class.

The executive committee of the union, through Mr. Applegarth, gladly responded to Professor Jenkin's proposal, and the Secretary remarked:—

'No proposal could be made in the interests of the working class, to which I could give such hearty support and concurrence as I could to a proposal for education, and technical education I know, too well, to be one of the greatest wants of the artisan class of this country, and that the machinery of the trades' unions may be adapted to supply that want (and that without in the slightest degree impairing their usefulness for trade purposes) I have long been convinced.'

Further correspondence led to an interview between Professor Jenkin and the executive committee, when his suggestions were most cordially approved, and it was resolved to facilitate the formation of classes in connexion with the branches of the union. Steps were immediately taken to make known to the members what was proposed, and ascertain who would be willing to join the classes. An arrangement was made by which members might obtain mathematical, drawing, and surveying instruments, on very advantageous terms. The following extract from the official report of the executive will show with what wisdom and zeal the work was undertaken:—

'So impressed are the executive committee with the importance of the undertaking and of its value to the trade, that they have resolved to leave no means within their power untried to make its adoption general and successful; and in the event of any branch or branches conjointly, or any number of members from 30 upwards, considering that a loan would enable them to start a school with greater chances of success, the executive committee will be prepared to entertain an application for a loan from the

contingent fund, and be ready to grant such loan when satisfied that the money will be usefully applied.

'We have been assured by many of the branches that the proposal is highly appreciated, and already names have been enrolled for the formation of schools. This is probably the first instance in the industrial history of our country of a trades' union undertaking to promote a plan for the education of its members. If successful, and we have full confidence that it will be, it will furnish a practical answer to the question, 'Do the working class want education?' and we hope will do something towards securing what the working class have so long desired, namely, a national compulsory and unsectarian system of education.'

From various branches of the union the executive received assurances of their hearty approval and co-operation. What was the entire number of students furnished to Mr. Busbridge's classes we are not informed, but from the fact that 116 were successful, we infer that there must have been from 150 to 200. Reviewing what has been done, Mr. Applegarth may well say, 'I feel more proud of this 'than of any other work I have ever had to engage in;' and certainly all the trades' unions of the country may justly feel themselves indebted to the carpenters and joiners for suowing now they may practically take up the question of education with such power and effect that in three or four years there would be among their numbers many hundreds of men, having had such an efficient technical education as to make themselves felt in the industry of the country, and give promise that labour would acquire a much higher status.'

1958. Are those schools specially connected with your own trade?—Yes, those schools are specially connected with our own trade, but Mr. John Stuart Mill, in writing to the Manchester men, compliments them very highly for extending the schools, so that it does not prohibit non-union men or even apprentices from attending them, which I think is very desirable that they should do. The one effort that has been made which is perhaps more commendable than all the rest, was a meeting of the board of arbitration, consisting of employers and workmen in Bradford, where the carpenters and joiners had a conversation with their employers, and they agreed that they would try their hand at forming a school for promoting technical education, and that is certainly one of the most encouraging features in connexion with the industries of this country; to my mind at least it is. The employers and the workmen have combined and taken a large house and divided it into class-rooms and provided all the necessities for teaching all, even from the young apprentice up to the old man, who desire to be taught the science of the trade with which they are connected. I have here various documents which were issued by the officers of that school calling upon the employers as well as the workmen to attend and give assistance. I find that during the time that it has been in existence, which is six quarters, in the first quarter they had 123 scholars attending, in the second quarter 126, in the third quarter 158, in the fourth quarter 130, in the fifth quarter 163, and in the sixth quarter 168, so that with one exception it has been a gradual improvement; and apart altogether from the improvement that it is to the men, I think that the masters and the workmen combining to promote education must lead to admirable results. I will put in a small list of the grants which our executive council have made from our fund to assist science classes in different parts of the country.

AMALGAMATED SOCIETY OF CARPENTERS AND JOINERS.  
Loans to promote technical education.

		£	s.	d.
Borough	Branch	-	-	5 0 0
Pimlico 1st	"	-	-	10 0 0
Greenwich	"	-	-	5 0 0
Manchester 1st	"	-	-	8 0 0
Manchester 2nd	"	-	-	7 0 0
Gray's Inn Road	"	-	-	5 0 0
Woolwich	"	-	-	6 0 0

I may just say that so far as regards the feelings with which it was granted, there was no money which our society spent which was spent more cheerfully than the loans for promoting education. There was a

Mr.  
R. Applegarth.  
1 July 1870.



Mr.  
R. Applegarth.  
1 July 1870.

committee established in London some time ago, with Lord Lichtfield at its head, for the purpose of promoting technical education, and I will put in a copy of the report of that committee (*delivering in the same*). They have not done very much beyond making known to the workmen the desirability of forming classes connected with the Science and Art Department. Under all circumstances I consider that the efforts of those men have been somewhat successful, especially considering the great difficulties that they have had to contend with, from the lack of elementary education. I consider that they have done more than we might have expected. In the London district there were about 120 of our members who took prizes in connexion with the Science and Art Department, which I consider very satisfactory indeed. Those who have visited these classes and know the men intimately as I do, would be led to wonder that they have even done so much as they have. I have seen men 25 or 26 or 28 years of age, sitting round a table, attempting to master the rudiments of the science of their trade, squaring out their elbows, put their tongues in the corners of their mouths, and turn their eyes into all sorts of shapes, and the result is called drawing. I have seen instances where men have made very clever drawings, and they actually have gone to some other friends there to get them to describe them, they were ashamed to put their own handwriting to their own drawings. Therefore, with all those difficulties to contend with, I think that the men in connexion with the science classes have done very admirable work.

1959. In all those schools together, do you know how many are now in attendance?—That I cannot say.

1960. But it must amount to a considerable number?—Yes, to a considerable number. What appears to me to be the most encouraging fact connected with them, is the growing desire on the part of the men to attend them.

1961. (*Mr. Samuelson.*) Would you be able to obtain returns of the number of persons now attending the science schools, in connexion with this special organisation of yours?—I have no doubt but that I should be able to do so. My principal object in calling the attention of the Commission to this, was that I thought it might be useful, if it were within the scope of this Commission, to push the inquiry as far as Manchester was concerned, or in one or two of those classes in London, to see what the men have actually done, and what they have left undone.

1962. Will you have the kindness to give the Commission the name of the science teacher in London of whom you have spoken?—Mr. Busbridge is his name, but I believe there are many science teachers who are not capable of teaching men what they profess to teach them.

1963. (*Chairman.*) You think that some of them cram in a little knowledge themselves, and then endeavour to cram it down others?—I think that some of them are crammed, and cram in return, but they have no real knowledge of the mode of imparting instruction to others.

1964. (*Sir J. Kay Shuttleworth.*) Nor much knowledge themselves?—Nor much knowledge themselves, their knowledge consists of cram, and they trust to cram.

1965. (*Mr. Samuelson.*) Did you procure this teacher, Mr. Busbridge?—I think he found me out from seeing a notice in the "Times" of what we were trying to do, he called upon me and we began to work together from that time, and are doing so now.

1966. Do you know what his course of training was?—I think he was a draughtsman in the arsenal, at Woolwich.

1967. (*Chairman.*) Upon the whole you are satisfied with him as a teacher?—Yes, highly satisfied. He is not only a competent teacher, that is to say, as far as his own knowledge of science is concerned, and he is first class at mechanical drawing, but he seems to have a special knowledge of imparting instruction to others.

1968. Do you wish to add anything upon that part of your examination with respect to what the men are doing for themselves?—I think I have given all that I wished to the Commission upon that point.

1969. I think you stated that you had some knowledge of what was doing in the way of technical education on the continent?—Yes, but I think it would be taking up the time of the Commission unnecessarily were I to repeat much that I do know, because it has been so fully stated in the blue books that have been issued. The most useful work that I have seen is the letter of Mr. Samuelson, concerning technical education in various countries abroad, which was printed by order of the House of Commons on the 26th of November 1867, and I gladly take this opportunity of thanking him for what I have learnt from it. I am sure that the Commission could not do better than refer to it. The trade schools to which he makes allusion refer particularly to the various branches of industry that he inquired into. The attempts that employers abroad are making to educate all their workpeople, is something very encouraging indeed. That is the way in which foreign industries are being developed, and that I hold is the way they must be developed at home if they are to be developed at all. I will just give the Commission one or two examples. Mr. Samuelson has given a very minute description of the works of Messrs. Schneider at Creuzot, and in connexion with those works, which are very large ones, there are schools for the purpose of teaching the workpeople. Mr. Samuelson says, at page 28 of his letter: "A very large proportion of the *personnel* of every rank in this great establishment was born and has been trained on the spot, and the possibility of thus forming highly skilled workmen, competent engineers, and accountants, is due in a great measure to a system of education, dating back as far as 1841, which though it is modestly styled elementary, is far more advanced and special than the term implies. The course, not necessarily followed throughout by all" (that is the course of education), "but open to all of sufficient capacity, extends over nine years, and includes advanced instruction in French literature, history, geography, natural philosophy, the chemistry of metals, algebra, geometry, mechanical and freehand drawing and modelling. The more promising boys are sent to the secondary and higher technical schools, and many a Creuzot labourer's son may be found, who, having passed through the *École des Arts et Métiers* at Aix, has returned to fill a responsible position in the technical management. The other boys are drafted from the school into the works and placed there strictly according to the capacity which they have shown at school; some as simple workmen, others as accountants, or as draughtsmen." He further adds, "there are adult classes less as a corrective of deficient elementary instruction, than as a help to those who wish to carry their studies beyond that of the school. They are held on Tuesday, Friday, and Sunday" (as Mr. Samuelson informs me, the Sunday school is a day school, but the others are night schools), "and included at the outset, reading, writing, arithmetic, geometry, natural philosophy, chemistry, geography, history, linear and freehand drawing, and music. But of late years six of the heads of departments, pupils of the *École des Arts et Métiers*, have been appointed to teach special classes bearing directly on the occupations of the workmen, and including, as one of the most important, a complete course of machine drawing. Though the proportion of adult pupils here, as elsewhere, is small, five per cent. of the whole number of workmen, the result is that Monsieur Schneider in walking through the sheds where several pairs of marine engines were being erected, was able to inform me that there was not a man amongst the mechanics employed in that department who could not make an accurate drawing of the work on which he was engaged." That has reference especially to the iron trade, about which



we have heard so much during the last few years. There is no wonder that the iron trade is being developed as fast as it is on the continent, if employers of labour consider it their especial duty to qualify their workmen to carry out their work as Mr. Schneider is doing. Fancy an employer of labour in this country being able to say there is not one workman engaged on an engine, or any part of an engine, but what is able to make a drawing of his part of the work. I do not suppose that any employer could say that, of more than a few (and those would be the most skilled workmen) in any of our large engine factories in this country, and, on the other hand, what may be said of iron works in different parts of the country, may be said of other branches of industry. Mr. Samuelson makes reference to the print works at Mulhouse. There is much the same to be said of them, and also the miners of Belgium have an equal opportunity of getting to be skilled workmen even in mining. It has often occurred to me, that if in connexion with the mining industry of this country, the workmen had every facility afforded to them to become skilled workmen in this manner, we should not hear of so many deplorable accidents as we do hear of.

1970. Do you know whether there are more accidents in proportion in England than on the Continent?—I believe there are. I believe there are more accidents in proportion to the population engaged in them in this country than there are either on the Continent or in America. There is one more paragraph which I should like to read in connexion with the mining industry. The miners of Belgium, in connexion, I suppose, with one of the particular firms that Mr. Samuelson alludes to, have an industrial school, and he says, "This industrial school satisfies a want which has been much felt, that of foremen rising from the ranks, who have handled the pick or the rabble, and who combine with practical knowledge and skill a certain degree of science and mental cultivation. These men serve as a connecting link and as a bond of union between the educated engineers and those of the workmen who are sufficiently intelligent and instructed to comprehend an order when it is given to them." The miners of this country have no such opportunities of becoming skilled workmen as the miners of Belgium have, and I am afraid that one of the results is that instead of our mining inspectors being chosen from practical men, who have practical as well as scientific knowledge of the trade, we are forced to fall back upon theorists who know only one half of what they ought to know, and as a consequence sometimes we hear of great explosions which are called accidents, but which are anything but accidents, and which I think might be prevented. I need not trouble the Commission with any allusion to the various trade schools which workmen have an opportunity of attending on the continent, as those are so well described in the blue books which are laid on the table of the House of Commons. But what I feel, as a workman, is, that in this country our workmen have no opportunities of becoming skilled scientific workmen, as compared with the workmen of the continent. And my surprise is, not that we have heard so much about foreign competition of late, not that we have heard so much about trade going away from England, but that we have not heard more of it. At the same time it is well that we should not believe every statement we hear about it, because opinions are very much divided, and there has been a great deal of exaggeration indulged in with reference to work going abroad. At the same time I cannot shut my eyes to the fact that English workmen are not quite able in many branches of industry with the hand, to compete with the head and the hand of foreign workmen, who have greater opportunities of educating themselves; and I conceive a technical education to be a part of a workman's right; just as I believe that an employer has a right to have a boy placed in his hand with a sufficient amount of scientific knowledge to ensure that he will turn out a moderately good workman, so do I hold it to be the right of the boy to have that scientific

education continued by the employer; and if not, I hold that the employer has no right to seven years' servitude of the boy.

1971. Do you think that there are any special qualities in a great number of English workmen which at all compensate for the want of as much theoretical knowledge as is generally possessed by workmen on the continent?—I am not a great believer in that cry, of which we have heard so much, about English workmen being qualified to beat the whole world, but I have a very favourable opinion of the working classes of my own country, and I am quite sure that they would be able to do far better if they had a good education; but it will not do for us to depend any longer upon that inborn ability which English workmen are said to possess, because even that can be overmatched by workmen who have a fair share of natural ability and every facility to obtain education.

1972. Do you see any symptoms of English industries being gradually supplanted by foreign industries?—That at once takes us to the question of foreign competition, and I am not aware how far that might be a branch of this inquiry, but I am prepared to go as deeply into it as you desire.

1973. If there is that supplanting, it arises especially from their superior knowledge?—There is no doubt of it. I think probably from Bradford you could get evidence which would be most useful and conclusive to show that in the dyeing trade, through the workmen on the continent having a special knowledge of chemicals and the science of chemistry, if they have not done it now, they very soon will take the very best of our dyeing trade away from us. I am not quite sure that some of the very best specimens of our dyeing are not done on the continent at the present time; I rather think it is the case.

1974. And that in consequence of the greater theoretical knowledge possessed by the workmen on the continent?—Yes, undoubtedly.

1975. (*Mr. Samuelson.*) You said that you thought that the limit of school age for an artisan should not be 12, but rather 14. You have no doubt heard it alleged, that unless boys are put to work at the age of 12 or 13, they are not likely to become skilled in the manual portion of their labour?—Yes, I have heard that, but I never believed it.

1976. It is your opinion then, that at any rate in the trade which you understand best, sufficient manual skill, and in fact a very high order of mechanical skill, can be acquired by boys who do not go to work until they are 14 years of age?—If they were to start at 16 and finish at 21, with such an education as I could desire to see them have, and with such scientific training as they ought to have along with their practical training, there would be a far better crop of workmen than we have at the present time.

1977. But as regards mere manual dexterity, you think that continuance at school till the age of 14 would not detract from that at all?—No, I know no branch of industry in which it would, and I cannot conceive any branch of industry in which it would.

1978. With what branches of industry are you sufficiently well acquainted to be able to express so decided an opinion?—Certainly, my own, the carpenters and joiners. As for bricklaying, I am quite sure that a man could learn all his trade in three years, and become a competent bricklayer, and I am quite sure that the trade of a mason is no more skilled, in fact a little less skilled than that of a carpenter and joiner. I do not know any branch of the iron trade, or any branch of the cutlery trade, and I do not know any branch of any branch in any way connected with the Sheffield or Birmingham trades, which could not be learned in the same time as our own could be.

1979. (*Sir J. Kay Shuttleworth.*) In three years?—I would not say three years, but I do not know any branch of industry that may not be learned sufficiently to enable a lad with a fair education to begin with, but he might learn to be a fair workman in five years beginning with the age of 14.

1980. (*Mr. Samuelson.*) I believe that your avoca-

Mr.  
R. Applegarth.  
1 July 1870.



Mr.  
R. Applegarth.  
1 July 1870.

tions have brought you very much into contact with the iron trade more especially?—Yes.

1981. So that you may be said to have a practical knowledge of that trade as well as your own?—Yes.

1982. (*Professor Huxley.*) Does your observation apply to those trades which involve so much sheer muscular exertion, for instance, smith's work; would not it be rather difficult to get a boy to take to smith's work at 16 or 17?—I do not see that it would be at all. I know branches of industry, where no boys work at them at all, they are too heavy even for boys to go to. The railway spring trade never take apprentices at all, they get only strong men, and when they have been at it a long time they learn the making of springs.

1983. (*Mr. Samuelson.*) In the manufacture of wrought iron, it is the fact, is it not, that boys scarcely ever go to work at puddling until they are at least 16 years of age?—No, boys could not work at it.

1984. In fact to put them to work at those heavy trades too early, would ruin their constitutions?—Yes, it would kill them off.

1985. (*Sir J. Kay Shuttleworth.*) But distinguishing the trades which require rather muscular strength and a developed constitution, and the trades in which it is desirable to develop the education of the hand and the eye, without specifying a particular period lower than 14, is it not important that at 14, the hand and the eye should be trained to great dexterity and skill?—I think a portion of that training which is very useful and necessary could be given in school. I think that the eye can be educated in the school as well as in the workshop. I have yet to learn that that cannot be done.

1986. How would you, for example, devise the training of the eye and the hand, with a view to any particular trade in an elementary school?—By scientific instruction, by diagrams and that kind of thing; and if any loss were in one way sustained, it would be compensated for by the lad's superior knowledge when he did start.

1987. Let me take the very familiar example of a man learning the use of the axe, who was afterwards to become a feller of wood or a shaper of timber, in any occupation connected with your own trade, do you consider that it would be wise that such a man should be trained from a period not later than 14 to use the axe?—I cannot see any benefit at all in going at an early age to learn the use of the axe or any other tool. I have heard a great deal said upon this point, about how useful it is to send lads to trades early, so that they might get in their youth a knowledge of those particular trades, and that their knowledge might grow with them; but my experience as a workman has been that there never has been that anxiety on the part either of the employers or of the foremen to teach this kind of thing to the lads. My experience has been rather that in our trade, certainly, and in the country more particularly, they keep a lad about two years dragging a handcart through the streets, running errands, boiling a glue pot, and all that kind of thing, which is the work of donkeys and unskilled labourers. That is the kind of work that lads are put to during the early part of their apprenticeship. I only wish there were something real in this anxiety to get lads to work so early.

1988. As between the neglect of the training of the hand and the eye in the actual manual occupation of the trade to which a youth is to devote his life and the skilled use of it, do you or do you not think it important that the training of the hand and the eye in actual occupation should commence not later than 14?—I think 14 is plenty early enough as a rule.

1989. But you think that it should not commence later than 14?—No, not later than 14; I would fix the age at 14.

1990. (*Mr. Samuelson.*) Your impression is that there is no real necessity for boys leaving school at 12?—Not the least.

1991. Is there no trade within your knowledge in which you would consider it to be necessary?—No.

1992. You stated that you thought it was incumbent upon an employer to give technical education to his apprentices. I suppose in saying that you speak strictly of apprentices and not of those who are merely boys hired as labourers?—No; I take it that it is a part of the duty of an employer to teach a lad the scientific as well as the practical part of his trade. Of course unskilled labourers would not come under that head at all, they would not be apprentices.

1993. In fact you spoke merely of those cases in which an actual apprenticeship takes place and where the employer undertakes to teach a lad his trade?—Yes, exactly so.

1994. You said that you considered it desirable that miners should have an opportunity of learning the scientific portion of their trade; are you aware that an attempt to do this was made at Wigan, and that it was unsuccessful?—I am not aware of any particular attempt, but I do believe that if you were to make a dozen attempts with the present class of miners, you would fail to a very great extent, but if you were to inaugurate a system of compulsory education and send all lads to school and keep them out of the pits till they were 14 years of age, and then make the attempt, I believe you would succeed.

1995. Then you attribute the failure of any such attempts as those at the Wigan mining school to the want of sufficient preparatory elementary education?—Undoubtedly.

1996. And you could expect nothing else than such a failure?—No; I think it is as natural as that the rain should fall from the heavens to expect such a result.

1997. You have given us some information about those technical schools which have been established in connexion with your particular trade; I believe that a great part of your time is occupied in composing the disputes between employer and employed?—That is part of my duty.

1998. And a very considerable part of your duty?—Yes. It has not been so much so of late years, because we have very fortunately inaugurated a system of arbitration which we are applying as speedily as possible, believing that it is more reasonable and more common sense like for an equal number of employers and workmen to sit over a table and bargain for labour as employers bargain for their timber and their stone.

1999. Is it within your experience that there is a great diversity of education and intelligence amongst the different workmen connected with your trade?—Yes.

2000. And do you find that those who have received the best primary education and who may also have received some modicum of technical education, are more easily dealt with or more ready to accept improvements and to further them than those who are not so well educated?—Undoubtedly.

2001. And comparing your own trade with other trades, is it the case or not, that you find in those trades in which the persons employed are the least educated, they are also those in which the resistance to improvements is the greatest?—Experience has proved that.

2002. From that you would conclude that precisely in proportion as education is advanced amongst workmen, so they will be more ready to adopt improvements, and so it will be more easy to compose disputes between employers and employed?—I have been saying that, as best I could, for years.

2003. You have thought it your duty to preach that doctrine?—I have, over and over again, for years.

2004. If such a happy state of things should be brought about, you think we should have much less to fear from the competition of other nations?—I feel quite convinced of it.

2005. You have spoken of the difficulties which workmen have to contend with in the establishment of technical schools; do you include amongst those difficulties the deficiency of proper buildings for hold-the science classes in?—Not only that, I include that and something more. We expected co-operation on



the part of the middle classes, who, I should have thought, would have been only too glad to assist the men in their establishments. The employers of labour have not given that countenance to these efforts that I think they ought to have given, and the outside public have not embraced the movement so warmly as I could have desired. As an instance of the difficulty that our men had in establishing a school in Pimlico, they actually had to take a school room to meet in which was connected with either church or chapel, on the condition that the teacher was to be chosen by the school committee. The committee's notions of religion were such that they even would not have science taught in their school without their choosing the teacher.

2006. That religious dogma and mathematics should go together?—Yes; in other places the great difficulty has been getting school room. They have had to pay a rather higher rent than their limited means would enable them to pay.

2007. Are you aware whether any efforts have been made by other trades to establish such schools?—I have not any information upon that, and I cannot say. I have not made any inquiry, for my duties are such that I cannot find time to make inquiry beyond my own particular trade.

2008. Have you heard of nothing of the kind amongst engineers?—I have not heard of it. Within the last two years whatever leisure I have had I have given to educational questions; but I have not had time to make inquiries of that nature.

2009. You visited Switzerland last year, did you not?—Yes.

2010. You have referred to publications on the subject of the technical education of workmen abroad, but I think the Commission would be glad to have some short account of what you saw in Switzerland in reference to that subject?—I must speak from memory: as far as technical education is concerned, I made but very few inquiries beyond inquiring into the operation of some trade schools which I was interested in, and I could not help contrasting the difference between the position of the workmen there and that of our workmen here at home. Take the watchmaking trade, for instance, one which I felt highly interested in; there the workmen are taught every branch of the watchmaking trade, whereas in England they teach but one, and that but very imperfectly. There all the workmen in addition to a general knowledge of how to make every part of a watch, and put it together when it is made, have an opportunity of going to the trade school (*école d'horlogerie*) where the science as well as the practical part of the trade is taught. One of the results of that is, that although a man in after-life may prefer to follow any particular part, the cylinder part, or the putting together, or whatever it may be, yet, having a general knowledge of the whole, he is a much better workman, for in addition to having a knowledge how to make his part, he knows in what relation each part stands to the other parts that another man must make. Therefore when he is making his own part he has something in his head beyond exactly the thing on which he is engaged. And in addition to that, it enables the Swiss watchmaker to command the shops of the world through the amount of general knowledge which he has obtained in those trade schools. There are other trade schools which I made inquiry about, with about the same results; they teach the workmen the scientific as well as the practical part of the trade, which is, of course, a very great advantage. One thing I was very much pleased with, and that was, that in going over large works, particularly the ribbon weaving factories of Basle, I found that the weaver at his loom knew something of chemistry; he knew something actually of the markets into which his ribbon would have to go; he knew what particular town in England his work was in competition with; and he knew how much harm, as we may call it, had been done to certain towns in England by the introduction or rather the development of that particular trade at Basle. On

questioning the man as to the fibres and the process of dyeing and the knowledge of chemistry necessary for the production of his work, the man at his loom seemed to have a general knowledge of every branch that really surprised me. The employer, of course, had a general knowledge of the trade from beginning to end, but the workmen seemed to have almost as much knowledge of the various branches of the trade as the employer had. That was not only surprising, but very encouraging. Compare that with some of the works here at home. Anyone interested in knowing how much, or rather, how little the leaders or the managers and foremen of the large firms have at home, has only got to make it his business to go over some of our large works, and he will find that beyond the qualification of bullying the workmen or something of that sort, there are many who have very little qualification at all. Some of them have neither a scientific nor a practical knowledge of their trade.

2011. You think it does conduce very much to the comfort of workmen abroad that their foremen are better educated than they are in this country?—There is no doubt in the world of it. I have often been asked how it is that workmen abroad, with all their education, are content to work for less wages than our workmen. I can only say this, that my practical knowledge of English workmen has led me to this conclusion, that if you give an English workman, say 1*l.* per week, and give him constant employment and treat him as a man, he would be far better contented than if he had 2*s.* a week and was bullied by an incompetent foreman, and working for an employer who cared nothing on earth for the man but only for the work that he could get out of him. Abroad men do work for less wages, and they seem to be content with low wages; they do not seem to have such a strong desire for an increase of wages as we have here at home; but, on the other hand, they are treated more as men than we are here, and in many parts of the continent they seem to be more contented with their position than we are with ours here at home, with all our high wages.

2012. Because the position of the men is more comfortable and agreeable?—Yes; but having said this much about the relative price of labour on the continent and here, I should like to say that workmen abroad are beginning to do the same as we have been doing here, viz., trying to get more wages, and they are getting more.

2013. (*Professor Huxley.*) Living is cheaper on the continent, is it not?—Yes, considerably.

2014. (*Mr. Samuelson.*) Have you come into contact with men of your own trade much in Switzerland?—Yes.

2015. Do you find that those men have or have not received a good elementary education?—They have, and some workmen were surprised at the inquiries I made of them in reference to education, especially, I remember, in Zurich. In the outskirts of Zurich I paid a visit to an acquaintance of mine, and was surrounded pretty quickly by about a dozen workmen and their wives and daughters, and when I asked the women in particular whether they had any objection to be compelled to send their children to school, they asked me if I thought they had not as much respect for their children's future as I had for the future of my own. They did not at all answer my question as to whether they were afraid of compulsion or not, but they said, "Do you think because we are compelled to send our children to school, that we are any more neglectful of the future of our children than you are of yours?"

2016. In fact the law compelling them to send their children to school was not felt at all by them?—No.

2017. Because they look upon it as their duty to send their children to school without any such law?—They felt it a duty, and they complied with the law with pleasure.

2018. If that law had ceased to exist, would they nevertheless have sent their children to school?—

Mr.  
R. Applegarth.  
1 July 1870.



Mr.  
R. Applegarth.  
1 July 1870.

Undoubtedly. I asked them, "Would you have any objection to see this law repealed, seeing that it is inoperative on the statute book?" They said, "No, we would not wish to see it repealed; there may be some man sometimes who will not do his duty to his little children, and then we would make him do it, therefore we would retain the law for that man."

2019. (*Dr. Sharpey.*) Let me ask you whether you readily obtain competent teachers for those trade schools in science or its applications?—No; there is very great difficulty indeed in finding teachers. A short time ago I assisted Mr. Sales, the Secretary of the Yorkshire Board of Education, as best I could, to get up a meeting in connexion with our society in Hull, with a view to form a class, and I am not quite sure, but I think they were not able to get a teacher in the town of Hull, and that the Yorkshire board of education had to send one either from Bradford or from Leeds expressly to teach that class; this must be a very great expense, but they were obliged to do it, because they could not find a competent teacher in Hull.

2020. I presume he became a resident in Hull?—No, he travels backward and forward by train at the present time.

2021. What inducement is offered to a teacher amongst your trade schools?—He has what the regulations of the Science and Art Department entitled him to, viz., payment by results.

2022. He is not paid any certain salary?—I think the teachers charge 5s. per man. When he organizes a school, he says, I will charge your men 5s. a head for the whole term.

2023. Is that paid by the pupils?—Yes, that is paid by the pupils. Then he has what the Science and Art Department allows, but no fixed salary that I am aware of.

2024. Can you inform the Commission what a man might earn in that way?—That I am unable to say.

2025. (*Professor Huxley.*) Do you think that the action of the Science and Art Department can be improved in respect to the promotion of scientific education amongst the working classes?—Yes, I think it can.

2026. Will you be kind enough to state in what direction you believe the working of it could be improved?—It may entail a great deal of expense, but I consider where it would be improved would be in this way, that where the salary the men were able to offer would not enable them to obtain a good teacher, the Science and Art Department should send a teacher down there to reside permanently, and when the requirements of the workmen find it necessary, to send an additional teacher down. I think that they should furnish ample teaching power. No matter what the expense to the Government might be, I think that it is essentially necessary.

2027. You are doubtless aware that this is directly contrary to the principles upon which the whole of the Science and Art Department is at present worked?—I am aware of that.

2028. Do you think that it is the business of the State to ascertain whether certain localities ought to have science teaching or not, and then to send somebody to do it?—Yes, I do. Of course there is a limit beyond which I would not desire to go. I do not believe in boys being nursed until they are men, and then nursed until they get to be old men. There is a certain limit to which I would confine even science teaching.

2029. But does not the State already offer sufficient inducements to any man of ability who can get a class to take the place of its own immediate action?—I do not think it does. But if we suppose it does, and no man thinks proper to become a science teacher, what about the thousands of workmen who may want to be taught science and cannot get anyone to teach them.

2030. Do not you think that if it were known that there were a sufficient number of people willing to pay, somebody would upon his own speculation, so to

speak, undertake to teach them science?—I have, no doubt it is the same as with anything else, that if a demand is created there will be a supply. But our great difficulty is this; we have the fact staring us in the face that in various branches of industry the continental manufacturers are running us a very sharp race; and what we want to do now as an industrial nation is, not to stand still and wait till the workmen call out in a loud voice that they want to be taught science, but to create a taste for it amongst the men. We have to create a taste amongst a lot of uneducated and illiterate workmen, and the question is, how are we to create that taste. My impression is, that under existing circumstances it is the duty of the Science and Art Department to do it, and to supply sufficient and efficient teachers. In the case of Hull, where, at a public meeting, a class was organized of earnest workmen ready and desirous of being taught science, the Science and Art Department ought to have sent an efficient teacher or teachers down.

2031. You are doubtless aware that the Science and Art Department does go so far as to send persons to the various provincial towns who are willing to explain the system and how it can be worked?—Yes, I am aware of that, but that is not science teaching.

2032. Then it is obviously the immediate interest of the employers of labour, if it be really the fact that the competition on the continent is becoming so great as to endanger their trades, to go to the expense of getting the aid of science teachers and not to throw it upon the general taxes of the country?—If they rightly understood what was for their own interest, employers would see it, but unfortunately they do not. I will tell you what is unfortunate for the employers of this country, more in their line, and is evident by a notice that I saw in the newspapers the other day of the contract for a new guildhall at Plymouth, where the price that one employer gave for the job was 57,000*l.*, and another offered to do the same work for 28,000*l.*, with the notion of cutting and contriving, and getting hold of the work at any price. To cut things as low as possible and pay the lowest amount for labour appears to be the object of the employers of this country, rather than doing their duty with regard to giving the public an honest article for a reasonable price. I merely mention this to show that I really wish, as you say, that the employers could see that it is their duty to assist the workmen by getting efficient teachers when the men express a desire to be taught science.

2033. You look upon it, in short, as something more than a question of the interest of a particular trade, it is rather the interest of the whole nation, that industries of all kind should be thoroughly well developed?—Certainly.

2034. And it is upon that principle that you would ask the State to interfere, and to that extent?—Yes; but I am sure it would need the strongest recommendation from any Royal Commission that ever sat upon the question, to induce the Science and Art Department to do it. If I am rightly informed, in the whole of Yorkshire, with a population of two and a quarter millions, there is not to be found a competent lecturer, such as our friend Professor Huxley, and if they were to apply to the Science and Art Department to send Professor Huxley, or any one else down, that Department would not send him.

2035. Do you think that any harm is done by concentrating such scientific lecturing power, on those subjects, as there is in London, or would you have such teaching under the Department distributed over the different towns of the country?—I would have it distributed over the different towns of the country, because, whilst it may not be altogether a waste of time to deliver lectures on all sorts of subjects to the population here in London, that have no connexion with many of the industries to which those lectures have reference, yet it cannot possibly be so useful as if an eminent lecturer were to visit the coal districts, and deliver lectures with special reference to the coal



industry. The same may be said of the iron industry, and everything else; and I think it is a piece of absurdity, to say the least of it, that if any locality expresses a desire that one of our eminent men should go down, that the Department should withhold that man or refuse to allow him to go. I do not suppose that individually they could prevent any one professor going, but that is not the thing. I say that the Department of Education ought to be prepared to give facilities to any one who desired anything of the kind.

2036. (*Dr. Sharpey.*) Are you speaking of lecturers merely, and not of special practical teachers?—Yes, of lecturers merely.

2037. (*Professor Huxley.*) The proverbial objection of carrying coals to Newcastle does not apply to carrying knowledge of coals to Newcastle?—By no means. In Newcastle there is too little knowledge of the industry by which so many earn their bread; in Newcastle they know too little about coal; and I am afraid that of the iron districts the same may be said about iron.

2038. Is there any other direction in which you think that the action of the Science and Art Department could be beneficially modified?—I cannot at this moment suggest any. I have taken as it were the ground from under my feet by suggesting that elementary science should be taught in our primary schools, and that would render unnecessary a great deal of what the Science and Art Department is now engaged in doing. What they are doing now, to a great extent, is teaching men what boys should know thoroughly, and if they would only free their hands of that, if only Mr. Forster in his wisdom could see the desirability of incorporating in his bill, or if under the bill elementary science could be taught, then the Science and Art Department, in my humble estimation, could devote its funds to a much more useful work than that which it is now doing.

2039. You spoke of a sort of antagonism between the Science and Art Department and the other half of the educational organisation at Whitehall; will you explain what you meant by that allusion a little more fully?—It seems to me to be an anomaly that two departments for the purpose of promoting education should have no connexion with each other. I understand that there are primary schools in this country where the schoolmaster undertakes to teach elementary science, and for the scientific teaching that he gives to his scholars, he gets a grant from the Science and Art Department, but he can get no assistance whatever from Whitehall for teaching primary education in his school. I should not be proud to belong to the board, or connected with either one of those departments that carried out such a stupid regulation as that, and I am not quite sure (I perhaps may be venturing on dangerous ground) that those who constitute the board of management at South Kensington quite understand the work on which they are engaged. I can only say, having the management of a large organisation, that if I had the power to issue, and made a practice of issuing, fresh regulations every week or every month, I could not expect those who were under my care to understand exactly what code of regulations or rules they were to be guided by. I should think that nothing was more calculated to upset the discipline and to injure institutions like ours than continually upsetting the previous regulations. That is what is complained of all over the country with regard to the Science and Art Department. And further than that, it is done in the most absurd and the most stupid manner. Fresh regulations are issued when the science classes are in full working, and those regulations are expected to be brought into immediate operation when they are in the midst of their session. It upsets all previous regulations, and the teacher, instead of being able to devote all his time towards teaching his scholars, has got to study a great deal and spend a great deal of his time to know what he has got to contend with under the regulations that are issued, which I think is very stupid as well as very injurious.

2040. Have you ever reflected how far that proceeding, which I quite agree with you in condemning, is to be laid at the door of the Department of Science and Art, and how far it arises out of the exigencies of parliamentary government in this country? I daresay you may have known cases in which a Chancellor of the Exchequer comes into office who takes a much more stern view of his duties than other persons, and it sometimes happens that he says, we must cut down the expenses of the country, and you must get it out of your departments somehow or other, I will not let you spend so much. Under those circumstances it is a little hard perhaps to throw upon the departments the poverty of the exchequer, but such things have happened?—There is a great deal in that, no doubt; but I can only say, that I wish the working classes of this country could see the power they possess, and were wise enough to use it, they would not allow any Government to trifle with the education of the country in that kind of manner.

2041. (*Sir J. Kay Shuttleworth.*) In connexion with your organisation, you, of course, avail yourselves of different classes of science schools, those which are established by certificated elementary teachers or voluntary teachers, those which are established in mechanics' institutions, and those which are established in special schools of science and art?—Yes.

2042. Looking to the various classes of schools and taking the humblest first, can you tell me with respect to the classes which are taught by certificated and voluntary teachers what degree of interest is taken in them by any of the employers of labour, as far as your experience extends?—My duties have been so heavy in other directions that I have not been able to follow up to any length an inquiry that would place me in a position to answer that question, so that my answer would not be of any value.

2043. Can you answer the question in respect of schools connected with mechanics' institutions?—I cannot definitely. I do know that in different parts of the country our members have taken prizes. I have had the pleasure of seeing an employer who was one of the directors of a school of art, hand over the prizes to his own workmen who were members of our society, but beyond that I do not know what interest the employers as a class have taken in it. I should be inclined to say that they have not taken very much interest, and considering that limited liability companies are swallowing up the small firms, I am rather afraid that the tendency is in the wrong direction.

2044. With respect to an early recommendation in your evidence that the employers of labour should undertake the scientific instruction of the youths apprenticed to them or employed in early life in their works, can you give us any instances in which that has been done by an employer of labour in this country?—Not in this country. There may be instances where employers have sent their lads to science classes and have paid their school fees, but that is hardly what I mean. I think that an employer should be called upon to give up part of a lad's time. In point of fact, it would not be giving it up, because the employer himself would reap the advantage of it in the later years of the boy's apprenticeship; I mean that a boy should be allowed to go so many hours to learn the scientific part, and the rest to learn the practical part of his trade.

2045. Does the present state of opinion among the employers of labour in this country, with respect to the theoretic instruction of their work people, lead them rather to depend upon the traditions of pure manual skill than to believe in any advantages to be derived from scientific instruction?—Whilst I could give instances of employers who appear to have a profound knowledge of the importance of the workmen receiving scientific instruction, and whilst I could give instances where employers have exerted themselves and given their time and their money to enable workmen to get it, yet, as a rule, I regret to find that employers have not taken that interest in promoting scientific education which I feel it desirable

Mr.  
R. Applegar  
1 July 1870



Mr.  
R. Applegarth.  
1 July 1870.

they should do; but I hope that the employers as a class will before long see the importance of co-operating with their workmen in any and every attempt on the part of the workmen to obtain scientific education, considering as I do that the industries of this country depend more upon education than upon past traditions of manual skill, which hitherto we have depended upon.

The witness withdrew.

C. SPENCE BATE, Esq., F.R.S., examined.

2047. (*Chairman.*) You are chairman, are you not, of the Plymouth Science School?—I am.

2048. Is the Navigation School of Plymouth a department of the Science School?—No; it is an independent school.

2049. And do you hold the same office in that school?—No.

2050. But you can give us some information respecting that school?—Yes.

2051. The Navigation School is a very large one, is it not?—It is a large one.

2052. How many students are annually in attendance?—They vary. I could give the numbers, but they vary very much. From one dozen to 50.

2053. You are of opinion, are you not, that the subjects of navigation and nautical astronomy are not fairly treated under the present system?—Yes; both towards the men and towards the teachers.

2054. Can you point out the defects on both sides?—The teachers are discouraged in their work, because the men often go to sea before the time for the science examination comes on, and, therefore, their time is lost. They would have to stay on shore a very long time in order to be present at the May examination, and thereby lose very much more time than is necessary.

2055. In this particular respect, can you suggest a remedy for that evil?—By having examinations such as we have for the officers in the merchant service, which are more frequent; I believe they are held fortnightly at some ports, and weekly at others, as at Plymouth.

2056. At present, I believe, there is only one uniform certificate?—That is all.

2057. You would suggest that there should be several grades?—Yes, in order to encourage the men to climb higher.

2258. How many grades do you think it would be desirable to institute?—Three, I should suggest.

2059. Have you any further suggestions to make with regard to the Navigation School at Plymouth?—I think not.

2060. (*Dr. Miller.*) Are not the examinations of the navigation schools quarterly, according to the minute of the Science and Art Department?—No, I think not. The complaint that the teachers make to me is, that the men go to sea after their work is done, and they cannot remain long enough on shore to wait for the time of the next examination to come up, the examination being in the month of May.

2061. I find at page 24 of the Directory of the Department, "In addition to the ordinary science examinations in May, class examinations are held in "mathematics, navigation, nautical astronomy, steam, "and physical geography, for the benefit of seafaring "men, and for them only, three times a year in all "seaports where local committees are formed, and "are willing to undertake them"?—I thought it was not so frequent, but then it is only on the condition that 40 candidates be presented from each school; officers in the merchant service have these examinations once a fortnight.

2062. Do you think that for seafaring men that would be sufficient to meet the case?—Yes, the examinations might be assimilated, and held once a week or fortnight for seafaring men.

2063. The Science School at Plymouth is a very extensive one, is it not?—Yes; it has rapidly increased from the first.

2064. Can you state some of the steps of its progress?

2046. Having regard to the imperfect education of the great mass of the workmen in such a town as Hull, I understand you to attribute that to the apathy arising out of want of instruction, and also to the traditional feeling of employers; would you suggest that means should be taken to awaken a deeper sympathy with scientific instruction?—I would.

—We commenced with some difficulty. We made an attempt first to found it in the year 1864, but utterly failed from the want of masters. We made a second attempt in the year 1865, and then succeeded far better than we anticipated. Our pupils at first were few, and they worked under considerable difficulties, and they work under very considerable difficulties now, with respect to accommodation. Our masters have not got sufficient room or space for their pupils, nor have they really the accommodation that is required for teaching. The pupils have been growing considerably in number, which, I think, would still increase if the committee had more to do with the management of the school, instead of leaving it so much to the different masters. If the Commission will allow me, I will hand in the following paper:

#### NAVIGATION SCHOOL AT PLYMOUTH.

Commenced 1862.

More than 2,000 individual students have obtained certificates.

THE subjects of navigation and nautical astronomy are not fairly treated under the present system.

Reasons:—The sailor, if he wishes to be examined in his branch of scientific instruction, must stay out of employment for some months in order to be prepared. This arises from the nature of his employment. He consequently is unable to maintain himself and family. It, therefore, precludes deserving men from endeavouring to elevate their position. As the Board of Trade examinations for sailors wishing to become officers are compulsory, the examinations should be assimilated, so that superior men should have some chance of having more than the rule of thumb methods now crammed into them.

Examinations of the men now are of too meagre a character, but sufficient if no inducements be held out to them for something better. It frequently takes the savings of years from sailors to enable them to stay ashore long enough to enable them to pass.

This re-acts on the teacher, inasmuch as he may spend many weeks or months on a pupil, who after all is compelled to go to sea before the time for his examination comes on. Whereas if the examinations could be assimilated, both teachers and pupils would be advantaged.

Under the present system of examination by the Board of Trade, the same certificate is awarded to all who pass, but if there were three grades in the final examination, viz.:

*Lowest* for those who just satisfy the examiners;

*Middle grade* for those who get a good place;

*Higher grade* for those who take full or nearly full marks;

This would produce a source of emulation among pupils, and induce men to work when at sea, instead of wasting, as now, nearly all their watch below.

#### PLYMOUTH SCIENCE SCHOOL.

This school was established in the year 1865-6, commencing with 4 masters teaching 7 classes, with 93 students, of whom 53 passed the May examination, taking 31 prizes, and 2 medals. Commenced 1866.

14 classes, 163 students; 148 passed, taking 41 prizes, 6 medals. 1866-7.

18 classes, 7 masters, 192 students; 156 passed, taking 60 prizes and 11 medals. 1867-8.

20 classes, 7 masters, 141 students; 46 prizes, 1 medal. 1868-9.

This year another school has been formed by one of the masters, who could not comply with a decision of the committee. 1869-70.

In the examination 559 papers have been worked by the pupils. The results of the examinations of the science classes held in Plymouth in May last have been forwarded from the Science and Art Department, South Kensington Museum. They are as follow:—

*Plymouth Science School.*—Number of papers worked, 252; number passed, 190; number per cent. who passed 75.4.

Navigation and nautical astronomy.

Suggestions

Examinations.



*Plymouth Charles Science School.*—Number of papers worked, 232; number passed, 149; number per cent. who passed, 64·2.

*Plymouth Navigation School.*—Number of papers worked, 8; number passed, 8; number per cent. who passed, 100.

The following table shows the per-centage from each school in every subject taught in Plymouth:—

Subject.	Plymouth Science School.	Charles Science School.	Plymouth Navig. School.
Plane and solid geometry { Class -	65·2	71·4	—
{ Honours -	0	—	—
Machine construction -	64	55·6	—
Building construction† -	33·3	29·4	—
Naval architecture -	100	100	—
Pure mathematics:—			
Stage I. -	91·7	41	100
Stage II. -	100	60	—
Honours I. II. III. -	80	—	—
Stage V. -	50	—	—
Stage VI. -	80	—	—
Theoretical mechanics { Class -	50	—	—
{ Honours -	0	—	—
Applied mechanics { Class -	100	100	—
{ Honours -	0	—	—
Acoustics, light, and heat -	38·9	87·6	—
Magnetism and electricity -	95	—	—
Inorganic chemistry -	86·5	—	—
Organic chemistry -	100	—	—
Animal physiology -	60	—	—
Zoology -	100	—	—
Vegetable physiology -	66·6	—	—
Systematic botany -	40	—	—
Navigation -	—	83·3	100
Nautical astronomy -	—	100	100
Steam -	100	94·4	—
Physical geography -	66·6	69·2	—

\* In this subject only 20 per cent. passed throughout the British Isles.

† In this subject only 14 per cent. passed throughout the British Isles.

Two in the last subject have taken 1st class honours in the Plymouth Science School, being the first who have so done, except men from the universities in competition for the Whitworth scholarships.

The restriction on dockyard pupils and engineer students works badly, as there is now no inducement for pupils to come from dockyards, as the teacher is precluded from earning grants, and the students from taking prizes. Thus Government withholds stimulants for study to those that are directly employed by them. This must have a prejudicial effect on their employer, as their wages are not sufficient to enable them to pay a private fee to the teacher.

As a proof that the teaching in the science schools is different to that received by such pupils, two students this year, 1870, from the Royal School of Naval Architecture, presented themselves at Plymouth, after having attended that school for four successive years. One of these failed in every paper he took. The other failed in about one half the number he took; one of these took a fellowship at the Royal School of Naval Architecture.

There can be no doubt that a great stimulus has been given to the cultivation of science by the present system, but while it encourages the masters to spread science, it offers them an inducement to extend their knowledge over many subjects, rather than to concentrate their powers on one or two. Consequently, masters cram themselves with superficial knowledge in order that they may teach several classes. The consequence is, that they know but little of the subjects they teach. It becomes a trade speculation with many to extend their classes, as for the same individual payments may be received on two, three, or more subjects, while more extensive knowledge in one subject produces less pecuniary results to the teacher.

The teachers in many instances are good, but, as a whole, the teaching appears to me to be in the hands of individuals that are not likely to elevate the standard of scientific education throughout the country.

The teachers are paid by results. By the present system of arrangement any teacher can form his own committee, select subservient friends, and indirectly manage the affairs of the school.

It appears to me that a great advantage would be derived by placing all the schools in certain localities under one committee of management.

That over a district there should be one responsible officer, who should be selected for his scientific attainments.

That he, in connexion with the committee, should have the power of directing the education, being himself a teacher in the head or central school of the district.

That he should have a voice in the selection of the masters teaching in such school with him.

That in such district a school house, with good appointments for teaching, should be a necessity.

That examinations should be practical as well as theoretical.

That payments should be made by Government as salary, by Government on results, and from pupils.

That in the central school of the district the head or other masters should have a small fixed salary and the use of the schoolrooms and appointments, be paid by the results of his or their pupils' success, and be allowed to take pupils of a class that can afford to pay him.

That in out-lying or branch schools, certificated masters should be paid by results, and be allowed to take pupils who can afford to pay them.

That scholarships of small sums should be awarded to the poorer pupils who show a decided qualification for any branch of science, to enable them to pass from the branch school to that of the central school of the district, and of larger amount to pass from the central district school to one of a still higher recognised position.

That in the establishment of science schools consideration should be had to all classes of the community, with a view of inducing the study of science among those who may enter professions or go to the universities. This latter should be encouraged as a source of revenue to the teacher.

That physical astronomy and meteorology should be taught as well as the other sciences.

2065. The school, I believe, now consists of 20 classes, under seven masters?—It does.

2066. I observe you state that another school has been formed by one of the masters, is that an independent school?—It is. One of our masters would not agree to certain resolutions which we thought were desirable, and he immediately formed a new school, that is to say, he got a committee and formed an independent school.

2067. In the last examination what was the number of papers that were worked by the pupils?—They amounted to 559.

2068. Of those were a very large per-centage successful?—Yes; 75·4 successful in the Plymouth Science School, 64·2 in the Charles Science School, and 100 per. cent. in the Plymouth Navigation School.

2069. In some branches, I believe, almost every candidate was successful?—I think in five branches every candidate was successful.

2070. Is that a very much larger per-centage of success than you obtained in the first instance?—Yes, the school is improving, although the examinations are becoming more severe.

2071. What are we to understand by the column headed "Charles School;" is that a school established by an independent master?—Yes, by a master who is a teacher in the Charles Church School. He is a teacher in the national school, and the clergyman of the parish is his chairman.

2072. Is that school entirely independent of the Plymouth Science School?—Yes.

2073. One of your pupils, you state, took honours on the last occasion in the Plymouth Science School?—They have frequently taken honours in science, but two this year have taken first class honours in mathematics, and I believe they are the first that have taken honours in mathematics who have not been university men. Those who in the Whitworth examination last year took honours were, one from Merton College, Oxford, another, a second wrangler, I believe, at Cambridge, and the third is anticipated to be senior wrangler this year from his high position.

2074. Is the examination of a very difficult character?—It is considered to be so.

2075. Are the dockyard pupils or engineer students admitted to the Science School?—They are admitted if they like to come, and they formed at one time a very strong body, but we lost a considerable number when the new restriction was put upon them.

2076. Will you state what that restriction is?—That masters in the Science School are not allowed to receive any payments for results by teaching those pupils, nor are the pupils taught in the dockyards allowed to take prizes.

2077. What was the reason for that?—It was thought that there being highly-paid masters already in the dockyard that was sufficient for them.

2078. And the pupils themselves, you think, suffer in consequence?—I think so. That will be shown by the fact that two pupils from the Royal School of Naval Architecture this year (one of whom, I believe, holds a fellowship at the Royal School of Naval Architecture) came up to be examined at our examination, and

C. S. Bate,  
Esq., F.R.S.  
1 July 1870.



C. S. Bate,  
Esq., F.R.S.

1 July 1870.

one of them failed in every paper that he undertook, while the other failed in nearly one half.

2079. I believe you can point out, by instances, that there must be some considerable difference in the teaching in science schools from that received by the dockyard pupils?—Yes; for instance, the master in the Plymouth Dockyard has to take too many branches. He teaches all the lower branches, ciphering, mathematics, and he goes into chemistry and almost every branch that is taught in our school. I do not think that the man's time is equal to it, even if he has the ability to teach all those things.

2080. Did that person whom you mentioned, fail in subjects in which, in your opinion, he ought to have obtained sufficient instruction in the Royal School of Naval Architecture?—That I am not prepared to answer, nor should I like to do so altogether. This is what I know took place at our school, that two of the pupils who went up to pass in our examination, were men from the Royal School of Naval Architecture, and I find that one failed in every paper that he undertook, and the other passed in half the subjects, but which of the two I do not know.

2081. Do you think that the teachers at the Royal School of Naval Architecture attempt too many branches?—I have not said that. What I said was with reference to the teachers in the dockyards.

2082. (*Professor Huxley*.) Were the subjects in which those gentlemen who presented themselves failed, such as are taught in the Royal School of Naval Architecture?—I understand them to be so, but I cannot say in what classes they were examined.

2083. Will you be so good as to let us know in what subjects the gentlemen to whom you referred were rejected?—

A. Failed in geometry	-	-	Honours.
" inorganic chemistry	-	-	Advanced.
" machine construction	}	-	Advanced.
and drawing		-	
" mathematics, stages	}	-	Honours.
1, 2, 3		-	
B. Failed in geometry	-	-	Honours.
" machine construction	}	-	Elementary.
and drawing		-	
" inorganic chemistry	-	-	Advanced.
" magnetism and electricity	-	-	Honours.
" metallurgy	-	-	Honours.
" Passed in mathematics, stage 3	-	-	2nd Class.
" acoustics, light, and heat	-	-	Advanced. 1st class.
" theoretical mechanics	-	-	Honours. 2nd class.
" applied mechanics	-	-	Honours. 2nd class.
" mathematics, stages 4, 5	-	-	Honours. 2nd class.
" " " 7	-	-	2nd class.

2084. (*Chairman*.) Do you think that the system established under the Science and Art Department has given much impetus to the cultivation of science?—I have no doubt that it has a preliminary.

2085. What do you think are the defects of the present system?—I do not think that the teachers themselves are the class of men that I should like to see as teachers of science; they are not scientific men. If, for instance, a mechanic or the master of a national school wishes to teach in any department, let it be geology, or any other, he passes an examination, crams for it, and then undertakes to teach. I think that such men as that cannot be fit to be teachers of science.

2086. Do you think that these last remarks apply to a large proportion of the teachers?—To a very large proportion.

2087. Have you found much of it in your experience?—My experience is confined to my own neighbourhood. From what I have heard from speaking to inspectors, it is very general, but there are not so many masters in most places as in the one instance that I have given. There are 20 classes and seven masters at Plymouth.

2088. Do you think that is a greater number of classes than seven masters are competent to teach with efficiency?—The reason of our breaking down at first was, that a master who had had five or six classes wanted to take three or four more. We appointed a master who was holding less classes and

who held, in our opinion, higher certificates. Because the former could not hold the number of classes that he wanted, he immediately resigned teaching in our school, and formed a committee and a school of his own, viz. the Charles School.

2089. In geometrical drawing and mathematics, are the teachers able, by cramming, to obtain sufficient merit in their pupils to procure payment by results?—That may not be so in mathematics, but in geology and in other subjects, it is possible. I have known a man who took up a certain class and who worked the pupils in it in order to pass. Sometimes they fail, but sometimes they succeed.

2089a. Have you any suggestion to offer for the improvement of scientific schools?—I think first of all, on the formation of a school, it should be as much as possible managed under one mind; and if you had a good head master and gave him more power than he has at present he would improve the school generally.

2090. Have you any further suggestions to offer?—In order to make the thing work well, I would allow the master to have the power of selecting his second master, with or without the aid of a committee, and that these might then have the power of selecting the third, and so on, so that you might have in the neighbourhood a good set of teachers; because if you put one good man at the head he will take care that no second-rate or third-rate man shall come under him, if he can avoid it.

2091. Do you consider the Government payment sufficiently large to obtain good masters?—No, not for the head master; certainly not.

2092. Would you make any alteration in the way of payment?—I think the head master should be well paid. He would have other work to do besides teaching; he would have to see that the teachers in the schools in the neighbourhood were properly kept up to their work, and consequently he, having other work to do, should have a fixed salary besides the payment by results, and he should have the use of the appointments and school-rooms in order to teach in.

2093. The payment by Government is solely by results at present?—Yes, at present it is.

2094. Are any funds obtained from private sources?—Very little. The fact is, the masters generally are not of that grade that those who can afford to pay would like to send their sons to.

2095. Do you, as a matter of fact, know how much any of your teachers make annually from that school?—Some have made as much as 100*l.*, but others as little as 5*l.*

2096. But they all have other occupations, have they not?—Yes, except the master of the navigation school; he teaches mathematics only, and navigation at his school, and teaches mathematics in the science school.

2097. Certain fees are paid by the pupils; is not this the case?—Only to the school, not to the master. The masters derive no benefit from the fees. The pupils pay 2*s.* 6*d.* each session, that is 5*s.* a year.

2098. Does that go to meet the ordinary expenses of the school?—It goes to meet the rent of the rooms, and, if there is a surplus, to the purchase of books and such things as may be necessary. At first starting a small subscription was raised to the amount of 30*l.*, which was subscribed chiefly among the committee themselves, and that was expended in the purchase of materials for the school.

2099. Are there no pupils in attendance who pay higher school fees?—Very few. I know but of three that have been there at all that pay a higher scale.

2100. Can any scholarships be obtained by the pupils at the science schools?—The Department grants 5*l.* scholarships to a certain class of boys, provided the locality will give also 5*l.* in addition to that. There are 10*l.* ones also, these are called science and art scholarships. The holders of both must always be connected with some elementary school.

2101. Do you find a difficulty in obtaining local contributions towards meeting the Government grant?—Yes, we cannot get any money at all locally.



We are trying now to build a school. I have made a great deal of effort to do so. We calculate that about 2,000*l.* will build a nice school, and we have got a promise of only about 300*l.*, so that I am afraid it will break down.

2102. Is the number of scholarships that the Government would provide limited, or would they provide as large a sum as the locality itself would provide?—I understand that they are prepared to give one scholarship in every hundred boys if the locality will meet them by subscriptions, but the boys must be connected with an elementary school.

2103. Then the number of Government scholarships is not limited?—No; the science directory will show that. I think I am correct.

2104. Do you recommend any change in that respect?—Yes; I think that if you had schools formed in a district, and supposing we had one central school in a place like Plymouth, with outlying ones at Devonport, Stonehouse, Torpoint, and Tavistock, all being in the neighbourhood of Plymouth, the head master should attend, and see that the teaching was properly carried out in those several schools. If he perceived that there was a lad in any of those branch schools who was well qualified to be encouraged in science, that boy should be able to win a scholarship in order to enable him to attend the central school, or if any boy in the central school showed great aptitude he should be able to gain a scholarship to enable him to come to London or other place in order to attend such teaching as would be then desirable.

2105. You contemplate the head master confining himself entirely to his duties as such?—No, I think not; he should supervise the whole of the schools as well as teach in the central school.

2106. But he ought not to engage in any other occupation?—No other occupation except teaching science in connexion with the school.

2107. Do you think that all science teachers ought to devote their whole time to their duties as science teachers?—That would depend much upon the size of the school that they would have.

2108. Are the Plymouth schools attended by persons from all classes of the community?—Chiefly mechanics. In fact, I have suggested to the master of the grammar school to encourage the science teaching of his pupils to attend those schools, but there seems to be rather a disinclination for a university man to send his boys to a national schoolmaster in order to learn science.

2109. They think that they could not derive any useful amount of instruction from him?—No, I think not.

2110. If the schools were of a higher grade, do you think that persons who intend their sons to go ultimately to the universities would send them as a preliminary step to a science school?—I do. I think that all masters of schools should be such men, and should have such qualifications that no pupil of any class ought to refuse to go there.

2111. Are you of opinion that any sciences are omitted which ought to be included amongst the branches of science taught in science schools?—I think physical astronomy and meteorology are left out, and I think they are becoming of national importance, and deserve to be taught.

2112. (*Professor Huxley.*) Have you any remedy to suggest for this great evil of 'cramming' to which you have alluded?—I think that men who are properly educated do not want to be crammed; that the examinations should be practical as well as theoretical.

2113. Do not you think that it would be very likely to be discouraged by the plucking on the part of the examiner of those pupils who showed evidence of cramming?—It would to a great extent, inasmuch as I know that it has had that effect; but I allude to the cramming in masters, not the pupils. I know masters, who having passed and taken certificates in six or seven papers, go in for more, and there is one whom I could name who has been plucked in some of those that he has tried.

2114. What I refer to is the very copious plucking

of candidates sent up by the masters?—I think whatever remedy is found desirable in these examinations might also be increased; but it should be directed so as not to discourage the pupil.

2115. You think it might be made more severe?—Yes; in the higher papers. I think that the object of the examinations should be, in the elementary paper, to see that the training given is of a correct kind. In the higher papers it should be a test of knowledge. The teachers' examination should be severer in degree than that of the students. This would remove the anomaly that at present not infrequently exists, of pupils taking higher places in the list than their instructors.

2116. (*Chairman.*) You do not think that there is any ground for complaint on account of the examination being too difficult?—No, I think not. I never heard, except one year, that there was a complaint, but I am not capable of saying whether it was just or not; I think it was in physical geography. This complaint was very general, the next year there was a different examiner.

2117. (*Dr. Miller.*) How do you propose to provide masters of sufficient eminence to hold such positions?—I think there are many scientific young men who are continually passing through the higher grades of schools, and if you can give them well-appointed schools to teach in, with a fixed salary, they would be very glad to take such situations.

2118. But is not it difficult to obtain a salary?—If the Government give a certain fixed sum with a well-appointed school, there is many a man who would be glad to have it, with the calculation that he will improve his school by his own reputation.

2119. (*Chairman.*) Do I understand you to be of opinion that the character of science schools could be materially improved without considerably more aid from the Government?—I do not think it could.

2120. And you would give that aid in the shape of fixed salaries?—Yes, I think so.

2121. (*Mr. Samuelson.*) Do you think it is reasonably to be expected that the central Government should do much more than it is doing in the case of localities which appear to exert themselves as little as, according to your statement, your locality has done?—I look upon it that science is a national thing and not local. If a man makes a discovery it must benefit the whole of society. The scientific men who work are never paid for the discoveries that they make; it is the next generation which obtains the advantage of them.

2122. With regard to your per-centage of those who passed, as shown in your table, were the pupils numerous in those cases in which all passed; for instance, in navigation and nautical astronomy?—In some of them it was so, and in some not. I think in naval architecture not very many, I believe five; and in organic chemistry there were eleven.

2123. Upon the whole, is the per-centage very great?—Very great, above 75 per cent. I have shown that in previous years there were a considerable number who actually passed, taking the aggregate school of the pupils. In the year 1867 there were 192 students, of whom 156 passed. I have not worked out the per-centage for this year. The reason of my having had the per-centage of 1870 thus worked out was because the statistics of all the classes not being obtained I could not give the exact numbers.\*

2124. In order to secure successful results, have you in your school organised anything like the system which you spoke of, of having the head master to superintend the teaching of the other masters?—We have been trying to do it in the committee, but we find that we are overruled by the masters, and we have not received that encouragement from the South Kensington Department which we think we should have had.

2125. In what way could they have interfered under the present regulations?—They would not interfere. The answer sent me was, that the school

C. S. Bate,  
Esq., F.R.S.  
1 July 1870.

\* This has since been done.



C. S. Date,  
Esq., F.R.S.

1 July 1870.

worked well and that they should prefer leaving it alone.

2126. Would they have been able to interfere under the present regulations if they had been willing to do so?—Yes. I think if we had been supported when one of the masters withdrew from us we could have kept the school together. We have just started this year a school in Stonehouse and one at Torpoint, which will be brought under the same committee.

2127. You think that the Science and Art Department would have done better if it had only acknowledged and supported the old committee?—I think so.

2128. (*Chairman.*) Do they give payments by results at the other schools?—Yes; to any certificated master who will choose to get a committee of a certain number, they will pay for results.

2129. (*Mr. Samuelson.*) Have not the Science and Art Department an officer whom they call their organising officer?—Mr. Buckmaster came round and suggested the thing, but I did not know that he was the organising officer.

2130. Do you know whether he is consulted on such questions as the multiplication of local committees?—I think he has no influence, inasmuch as the changes took place when he was in our neighbourhood, and he gave us suggestions to work by, which in each case were ignored.

2131. By the Department?—Yes.

2132. Have you any knowledge of the classes for instruction in mining, which have been organised in Cornwall, and, I believe, in Devon also?—No.

2133. (*Chairman.*) You have stated that there is very great difficulty in obtaining funds from private sources; is there any interest taken amongst the people of Plymouth in other ways in the school?—Very little. We have a large committee at the head working through the year, but the work is generally done by some very few; two or three are expected to be present on examination evenings, to see that no unfair work takes place on the part of anybody.

2134. Have you a difficulty to find persons willing to give their time and trouble?—Yes; but many of them attended rather more numerously this year during the month of May. Several on our committee are merely put on on account of their local influence.

2135. Do a great many members of the committee consist of the private friends of the teachers?—No, I think not. I will, with the leave of the Commission, hand in the programme of our school for this year's session.

#### PLYMOUTH SCIENCE SCHOOL,

Under the Department of Science and Art, South Kensington Museum, London.

President—The Mayor of Plymouth.

Chairman—C. Spence Bate, F.R.S., F.L.S., &c., &c.

Treasurer—Robert Bayly.

Secretary—J. H. M. Cawse.

#### Committee :

A. P. Balkwill.  
Richard Bayly.  
F. P. Balkwill.  
J. N. Bennett.  
R. Bishop.  
T. R. A. Briggs.  
Eldred Brown.  
Henry Brown, J.P.  
C. F. Burnard, F.C.S.  
S. Cater.  
Rev. J. M. Charlton.  
Dr. R. H. Clay.  
G. Clifton.  
W. F. Collier.  
Rev. F. Courtney.  
G. H. Eccles, M.R.C.S.  
Rev. T. Freckelton.  
W. Haddy.  
A. S. Harris.

Francis Hicks.  
A. Hingston, J.P.  
G. R. Holberton.  
G. Jago.  
I. W. N. Keys.  
Henry Luscombe.  
W. V. Moore.  
J. Marshall.  
T. Pitts, jun.  
Capt. Puckford, R.N.  
A. Prowse.  
W. Radford, J.P.  
A. Rooker.  
W. Square.  
J. Saunders.  
J. Shelly.  
R. E. Waddington.  
C. Whipple, M.R.C.S.  
F. H. Westlake.

This science school will recommence on Monday, October 4th, 1869, at the Science School-rooms, Courtenay Street, Plymouth.

The following classes will be opened immediately :—

Practical, plane, and descriptive geometry, at 7 o'clock on Wednesday evenings.

Building construction, at 8 o'clock on Wednesday evenings.

Mechanical and machine drawing, at 7 o'clock on Friday evenings.

Naval architecture, at 8 o'clock on Friday evenings. (Under Mr. G. Rickard, certificated teacher, Department of Science and Art.)

Elementary mathematics, at 7 o'clock on Monday evenings.

Higher mathematics, at 8 o'clock on Monday evenings.

Theoretical mechanics, at 7 o'clock on Wednesday evenings.

Applied mechanics, at 8 o'clock on Wednesday evenings.

Navigation, at 7.30 o'clock on Friday evenings.

Nautical astronomy, at 8.30 o'clock on Friday evenings. (Under Mr. Merrifield, Ph. D., F.R.A.S., certificated teacher, Department of Science and Art.)

Physical geography, at 7 o'clock on Tuesday evenings. (Under Mr. Sargent, certificated teacher, Department of Science and Art.)

Steam.

Acoustics, light, and heat, at 8 o'clock on Monday evenings. (Under Mr. Shopland, certificated teacher, Department of Science and Art.)

Animal physiology, at 8 o'clock on Saturday evenings.

Zoology, at 8 o'clock on Tuesday evenings. (Under Dr. C. A. Hingston, honorary certificate, Department of Science and Art.)

Inorganic chemistry, at 7 o'clock on Tuesday evenings.

Organic chemistry, at 7 o'clock on Thursday evenings.

Magnetism and electricity, at 8 o'clock on Thursday evenings. (Under Mr. A. J. Rider, certificated teacher, Department of Science and Art.)

Mineralogy, geology, and metallurgy, Thursday mornings and evenings. (Under Mr. H. Hodge, late lecturer on chemistry and mineralogy, School of Mines, Royal Institution of Cornwall, holding certificate and testimonial from the Royal College of Chemistry, London, 1849 and 1850.)

Vegetable physiology and economic botany, at 7 o'clock on Friday evenings.

Systematic botany, at 8 o'clock on Friday evenings. (Under Mr. F. P. Balkwill, F.L.S., M.P.S., certificated teacher, Department of Science and Art.)

#### Classes in Devonport.

Practical, plane, and descriptive geometry, at 7 o'clock on Tuesday evenings.

Naval Architecture, at 8 o'clock on Tuesday evenings.

Mechanical and machine drawing, at 6 o'clock on Saturday evenings.

Building construction, at 7 o'clock on Saturday evenings.

These four classes will be held by Mr. G. Rickard, at the Mechanics' Institute, Devonport.

Fees, 2s. 6d. for each of the two terms. Private students by special arrangement.

Attendance will be given on Friday and Saturday, 1st and 2nd of October 1869, at 7 o'clock, at the rooms in Courtenay Street, to receive the names of persons wishing to join either of the classes. Those to whom the above hours are inconvenient are referred to Mr. R. E. Waddington, 149, Union Street, who will receive names or furnish information.

To all persons seeking Government employment or promotion, these classes afford an excellent opportunity of preparing themselves for the examinations now required before they can fill any public situation.

Prizes of medals, books, instruments, certificates, &c., have been awarded by the Department of Science and Art to the majority of the students who attended the classes last winter. These will be publicly distributed as soon as they are received. The Government examinations will be held in May, at which every student will be expected to present himself.

The witness withdrew.

Adjourned to Tuesday next at 11 o'clock.



No. 6, Old Palace Yard, Westminster, Tuesday, 5th July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

Mr. THOMAS WILLIAM SHORE examined.

2136. (*Chairman.*) I believe you hold an appointment, under the East Lancashire Union of Evening Schools, connected with mechanics' institutes and other schools?—Yes.

2137. Will you explain the nature of your appointment?—My duty primarily is the organization of elementary classes in connexion with the various mechanics' institutions, with the superintendence of the elementary instruction in those classes, the actual teaching of some branches of elementary instruction, and before or after the ordinary hours for the elementary teaching, I conduct the science classes. I pay weekly visits to five separate evening schools, and the annual payment by the local authorities to the East Lancashire Union is 15*l.* for my services one evening per week.

2138. Do you pay a visit once a week to each of those institutions?—To five.

2139. Not one of the five every week, but all the five every week?—Yes.

2140. Does each visit take up the whole evening?—Yes.

2141. You never can visit two the same evening?—Not unless they be in Burnley, where the two are close together, and on Saturday evenings, which is an exceptional case. As a science teacher, my duties consist in teaching one or two science classes each evening.

2142. Either previous to or after the ordinary instruction?—Yes; and my occasional duties are visiting those or other institutions at their annual meetings. I give some addresses to the members of the various institutions upon their classes, and I occasionally advise the committees with regard to the organisation of their classes, upon such subjects as the advantage of science classes, the best methods of teaching, the means of preparing pupils for the annual examinations, and similar topics. My remuneration is 120*l.* per annum from the East Lancashire Union, and the payments on results of the science examinations, from the Science and Art Department. The average of this latter payment for five years has been about 92*l.*

2143. In how many branches do you teach yourself?—I have taught five branches during the last session. In the previous session I was engaged in teaching seven different branches; it may vary from year to year.

2144. Will you state what are the branches in which you give instruction?—Theoretical mechanics, applied mechanics, acoustics, light and heat, magnetism, and electricity, inorganic chemistry, organic chemistry, animal physiology, geology, vegetable physiology, structural botany, and physical geography. I have taught the whole of those subjects in the course of the five years that I have been engaged in the Union.

2145. Can you give us any information as to the way in which instruction in science is carried into effect at the several mechanics' and other institutions?—The Union comprises about eight mechanics' institutions, and 10 separate evening schools in connexion with other establishments, such as ordinary day schools. Previously to the establishment of the scheme of the Science and Art Department, by the minute of June

1859, class lectures in science by my predecessors were a feature in the organisation of the union, four lectures on such subjects as water, and air, and the steam engine, were given successively to various institutions. These lectures were, I think, amongst the first efforts at the systematic teaching of science in Lancashire. The instruction in the union is based upon a thorough knowledge of the English language. The prizes and certificates which are awarded by the union are made dependent upon a thorough knowledge of this subject, and consequently the way was clear about the year 1860 for the adoption of the scheme of the Science and Art Department. The scheme of the Department depending upon written examinations only, this knowledge of the English language, required from all the pupils of the institutions under the union, was found of great service. Science schools were established in 1860 or 1861:—two in Burnley, one in Haslingden, Accrington, Rawtenstall, and shortly afterwards in Bacup. The subjects taught by my predecessors were, in the main, the same subjects as are now taught by myself. The average aggregate number of the science pupils under my own instruction for the last five years has been about 140, the average number of successful examinations passed by the pupils has been about 64. I have kept rough memoranda. I cannot give a precise average. I have tried to put the average, certainly not above the mark. I find for the present year the number of successful examinations passed by the pupils during the past session has been 72; during the last session the average number of successful students is about 48 or 50, for the last year it has been 58.

2146. What is the average number of students that you send up for examination?—The number who go up for examination is about 70. The per-centage of those under instruction who go up for examination is about 45, and the per-centage of those under instruction who pass is about 36.

2147. The same students go up in more than one subject, do they not?—Yes, but I may perhaps throw a little light upon what I mean, if I mention that the number of successful examinations of students taught by myself this year has been 72, and the number of successful individuals 58.

2148. (*Professor Huxley.*) How many did you send up this year for examination?—There were about 90 sittings, and from 70 to 75 candidates.

2149. (*Chairman.*) What is the number of separate classes taught by yourself?—The number of separate classes taught by myself during the last four years has been about 12 annually. I added a new feature to my work in the September of last year. I opened a special class for certificated masters of day schools. This class is held on Saturday mornings, the most convenient day for the teachers, and it has been attended by 12 masters of elementary schools; nine of them went up for examination in May, and passed in different stages in inorganic chemistry. The present effect of this class is, that the interest of teachers in science has been greatly aroused, and several of them are introducing rudimentary science lessons voluntarily into their day schools, and they are all anxious that the class should be continued, that this

Mr.  
T. W. Shore.  
5 July 1870.



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T. W. Shore.  
5 July 1870.

subject and others should be taught during the next session, and I have had applications from other teachers to become members of the class. The East Lancashire Union of Institutions has been instrumental in establishing other classes not associated with it, and this has been brought about chiefly by some of the best pupils who have received instruction in the classes of the union, opening classes as teachers themselves in other parts of the district, and in one instance a predecessor of my own, on resigning his appointment, opened a class in another part of the district, and there taught several professional teachers who are now teachers of science.

2150. You stated that all the class lectures are based upon a knowledge of the English language: are we to understand that there is any examination in the English language as a preliminary?—The scheme of the union includes an annual examination, which is held in the month of June; certificates are given to those who attain a certain degree of proficiency in the examination, and prizes to the most proficient; but no prize or certificate is given to a candidate who fails to show a competent knowledge of the English language in the several classes in which he enters.

2151. Are you able to give the Commission a general view of the science instruction in north-east Lancashire?—I am not intimately acquainted with the whole of the science schools, but I have a general knowledge of them. The number of classes is from 75 to 80. These are held in 26 separate institutions, or schools, 10 being connected with mechanics' or literary institutions, 11 with elementary day schools, and five established in other educational institutions. And with regard to the teachers, 11 are masters of elementary day schools, and I think I may say all, or nearly all of them, have, during the winter months, either the actual care or the nominal care, by the aid of an assistant teacher, of an evening school; 10 teachers of science in the district, including myself, are not masters of elementary day schools. The strain upon those day school teachers in the extra work of teaching science classes is, I think, scarcely so great as the work of teaching evening schools. Probably they find it a means of a little change of occupation. The more advanced scholars of our evening schools usually are drafted into our science classes; in some cases the more advanced boys attending day schools, and, in some instances, female scholars enter the classes also. I believe that in one or two instances there is a mixed science class. In the evening schools the more advanced scholars are allowed to pass standard six of the revised code more than once, under certain circumstances.

2152. Will you state what standard six of the revised code is?—Standard six is as follows:—*Reading*: A passage from an ordinary newspaper, or a book of general information. *Writing*: A passage of the same kind from dictation. *Arithmetic*: Practice and bills of parcels. It is the highest standard of the revised code, and, as an exceptional case, the evening scholars are allowed to pass this standard more than once; it consequently happens that sometimes a scholar passes standard six in one year, and comes up again for standard six the following year. He therefore finds little stimulus before him in passing the examination that he has already passed; and consequently, if a science class is opened, those scholars obtain a benefit from it, and the science class reacts upon the evening school and gives a higher tone and character to it. The qualifications of the teachers of science classes have chiefly been obtained by passing the advanced stage of the class examination. I think about four teachers, omitting myself, have obtained one or more qualifications from the Science and Art Department under the system which existed previously to 1867. All the others are qualified to teach, by passing the examination for the classes. Intending teachers are not now, as formerly, examined in any practical work, either in teaching, or in any practical work in chemistry, or other kindred

subjects, nor are they examined *viva voce*, as formerly, by the examiners: and in the case of some teachers, of the subjects 1, 2, and 3 of the scheme of the Department;—(1.) Plane and solid geometry. (2.) Machine drawing and construction. (3.) Building construction, which subjects are allied very much, some teachers' qualifications are very moderate. I question in some cases whether a thorough knowledge of even their own language is possessed. Many of them are practical men in their respective trades, foremen in works, draughtsmen in foundries, and successful youths, and young men of other occupations. The other teachers of those subjects are teachers by profession. With regard to the inducements to schoolmasters to become science teachers, the chief is, in nearly all cases, the additional remuneration, and I think, in a few instances, a liking for science teaching may also be a reason. More teachers would endeavour, I think, to qualify themselves if they regarded the scheme of the Science and Art Department as more likely to continue. I have heard this expressed to me by many teachers, so long ago as 1864. This want of confidence in fact I consider has retarded science teaching. It is not peculiar to the scheme of the Science and Art Department, but since the date of the revised code that feeling has been entertained by day school teachers with regard to the scheme of education for their day schools. Formerly a master who had a pupil teacher apprenticed to him, was considered disqualified to receive grants for science teaching. In this way I was disqualified myself for two years. The sudden changes of the Science and Art Department have greatly increased the want of confidence. School teachers seem quite alive to the importance of a knowledge of science; they consider that it is necessary for them to acquire some scientific knowledge, and some qualifications as science teachers, in order that their professional status may not be lowered. This is particularly the case with many schoolmasters of 10 years' standing, and it has been brought about in some instances by the younger teachers having greater opportunities. I consider from the results of my own attempt at forming a special class for schoolmasters, that the present is a favourable time for establishing such classes, and I think that the introduction of the simplest science teaching into day schools would be best accomplished by first giving sound instruction to the mass of the teachers. If extra grants were offered to classes of school teachers, certainly in central districts, I think there would be but little difficulty in raising such classes. I think this, mainly because the feeling amongst the older teachers, that they must do something in order to compete with the younger members of the teaching profession, who are now leaving the training colleges, and who commonly possess some qualification in one or two branches of science, is very great, and so the older teachers are thus aroused. At the present time certificated teachers are required to pass even in stage I in mathematics, before they are allowed to teach. I think that this is unnecessary, as being a loss of labour and of time.

2153. (*Sir J. Kay-Shuttleworth*.) They are also required, are they not, to pass in six books of Euclid?—In the main they have been required to pass a mathematical examination, beyond the requirements of stage I in the present scheme, and their certificate is of course evidence that they have been successful. I think also that a general diploma, or general science certificate, for science teachers, would be desirable. I think this because the tendency of the Department of Science and Art has been to subdivide the subjects of examination constantly. Such a certificate would also offer a very useful stimulus to the most successful science teachers, and by obtaining it, after passing a number of examinations, or after teaching successfully for a certain period, or the two combined, they would obtain a recognition which would be very useful to them, and it would, I have no doubt, react upon the classes very beneficially. Some teachers at the present time qualify themselves in the ordinary



science classes, others by private study. I have known of instances in which first classes in chemistry in the advanced stage have been obtained from book work only. This qualification, until May last, was the highest qualification given by the Science and Art Department to teachers of chemistry, for two years after the substitution of the class examination for the examination of the teachers in February 1867. No higher qualification than this first class in the advanced stage was given. At the present time teachers can enter the honours examination established in May 1869. I pointed this fact out to the Science and Art Department three years since, in a report that I sent in, after a visit to the exhibition at Paris, and I laid particular stress upon it at that time. Twenty persons were studying science in my own classes with a view to becoming teachers last session.

2154. Can you state the occupations of those persons generally?—Sixteen were professional teachers, and the remaining four are either at present engaged in teaching science in addition to their ordinary occupations, or are intending to do so. With regard to practical and illustrative teaching all the science schools connected with the institutions of the East Lancashire Union, where chemistry is taught, possess a sufficient amount of chemical apparatus for the chemical lessons. This will probably be increased by the recent minute of the Science and Art Department. By this minute grants are offered for the establishment of small laboratories, and for the purchase of articles of a destructible nature. The Union supplied large boxes of models, and apparatus for teaching mechanics and physical science, and diagrams for natural history, and these may be circulated. They are used by myself, as required, for the different science classes. Four or five schools, not connected with my own duties, are, I think, supplied with a fair amount of apparatus; two more particularly so than the others. The present system of examination affords little encouragement for practical work, or the most practical methods of teaching. The recommendations of the examiners for the last few years have tended very considerably, or are tending now considerably to improve this. One recommendation which was put into form, and issued to the schools in the course of the last few months, was that by Dr. Frankland, and I believe that now no person is to be passed in the advanced stage of the examination in chemistry without showing a practical knowledge of practical chemistry, or qualitative analysis.

2155. (*Professor Huxley.*) Are you aware of anything having been done to make the teaching of physiology more practical than it was?—Yes; I remember very well a series of lectures delivered by Dr. Foster in July last, as, I believe, the result of your own recommendation to the Science and Art Department. The average age of the pupils is from 16 to 20, in my own classes. In some classes taught by schoolmasters the age is lower than this. Sometimes they form a class of boys from the elementary day schools, and they teach this class, either after the morning or the afternoon meeting of the school. Nearly all the science students in the institutions connected with the East Lancashire Union possess attainments beyond standard six of the revised code. There are exceptions; of course, and the common ones are those cases of students of adult age desiring to learn some branch or branches of science which have a direct relation to their occupation. Nearly all the students in the classes which I teach myself, and those connected with the Union, have passed one or more of our own examinations, and those have given evidence of a knowledge of the English language and the English grammar, greater or less according to the class they have passed. Students usually enter one class first; if they fail in their first examination many are discouraged. I think this shows the desirability of a low standard for the first pass or first success. Some students continue in the classes for periods of from three to five or six years, and in some instances they attend classes in other

subjects, when engaged in teaching some of the subjects on their own account. When elder students have passed in subjects 1, 2, and 3, or one or more of them, they commonly establish classes in these subjects. It has been found that it is easier to raise classes in these subjects, than in those of an experimental nature, and the three subjects, 1, 2, and 3, are usually taught when the teacher is qualified for them, on one evening, one after the other, without interval. With regard to the proportion of pupils who pass the examination, of those entering the classes I find that from 30 to 40 per cent., and in some instances more even, drop off and cease to attend. Many circumstances tend to bring about this, in some cases removal from the district or town, in some cases illness, in some cases an increased briskness in trade, in some instances seeing that their education is not sufficient to carry them on through the course; and of those who do go into the examination, from 75 to 90 per cent. pass, and sometimes more. This, however, varies. As an illustration, in one subject of last session, 22 students entered the examination, and 21 passed, in applied mechanics. In some instances the number is not so favourable, while in some cases all those who enter the examination pass. To a very considerable extent this depends upon the general education of the candidates. In the case of the schoolmasters' class we had no failures. When teachers have classes at their own evening schools, this being quite a voluntary work on their own part, they are now beginning to impose certain conditions upon the students entering their classes with regard to attending the annual examination. I am informed by the teacher of the Wesleyan school at Blackburn, who is perhaps the best qualified teacher in the district, that he insists upon a guinea being paid by each student who fails to attend the examination, and that in one or two instances this has been paid, and the result of this condition has been that 80 per cent. of the total number of students under instruction by him have passed the examination. In one case he informed me that more than 90 per cent. of the students in one class passed the examination, and I think the subject was one of experimental science. I have never attempted it, and I think it would be very difficult to do this in classes at mechanics' institutions, and this teacher coincided with my view, as he had also been a teacher at a mechanics' institute, because there the classes are all open to the members of the institution; the institution is conducted upon certain rules, and the students and teachers are all subject to those rules, and therefore I think there is some reason for the great difference between the per-centage who pass in connexion with mechanics' institutions, and those under exceptional circumstances, as in the case I have mentioned. The number who pass varies very greatly in those schools where these conditions or similar ones are not required. In one school, unconnected with the Union, I have heard of an instance of four passes from five candidates out of a class of originally about 50, and in another of about 17 passes from an original class of 80 students. With regard to the students' fees and the prospect of classes being self-supporting in institutions, the members' fee is usually 2s. 6d. per quarter, in some instances 2s., and sometimes a small fee is paid to the various special classes, besides; 2s. is a common fee. In chemistry classes it is usual for the students' fees to cover the expense of the chemicals, &c. In elementary schools the question of fees varies. In some instances nothing is charged beyond, perhaps, the fee for being a member of the evening school, but in other cases, I believe, fees are paid. It is stated in the Science Directory of the Department that the grants must not be looked upon as permanent, and committees are recommended to impose as high a scale of fees as possible. I scarcely think I can quote the exact words, but it gives me the impression that a self-supporting scheme is what the authorities of the Science and Art Department ultimately look for. I think that there is very little prospect of such a self-supporting scheme for at least

Mr.  
T. W. Shore.  
5 July 1870.



Mr.  
T. W. Shore.  
5 July 1870.

a generation or more; and amongst the reasons for this, are, the defects in primary education, the want of interest in science shown by many school managers, the apathy of many, I may say of most, manufacturers, and the indifference or want of appreciation of the value of science in the great bulk of the working population.

2156. (*Sir J. Kay-Shuttleworth.*) Will you be kind enough to state what was the course of training through which you went, before and since you took your certificate as an elementary teacher?—I became a teacher in the year 1851 as, originally, a paid monitor. In 1852 I was apprenticed a pupil teacher in a boys' school, under the Committee of Council. I entered, as first-class Queen's scholar, the Oxford Diocesan Training College, at Christmas 1856. I resided for two years at that training college, and I left at Christmas 1858, with a certificate of the second year of the second class. I was then appointed as master of a mixed district school in the neighbourhood of Gloucester, and I held that appointment from  $4\frac{1}{2}$  to 5 years. I had pupil teachers there. I studied science partly in the training college, not so much as part of the curriculum of the training college at that time, as from a natural liking to science, and from very valuable assistance given me by a scientific man who was the vice-principal. I continued my study of science during my first appointment as schoolmaster, coming up to South Kensington to attend the various examinations, and obtaining four certificates as a teacher of science during that appointment, in acoustics, light and heat, magnetism and electricity, animal physiology, and theoretical mechanics. At Christmas 1863, I was appointed head master of a large boys' school at Redditch, south of Birmingham. I commenced a science class in connexion with the Literary and Scientific Institution there. I had the assistance of a second certificated teacher, and so I taught the morning school with him; I was free in the afternoon, beyond the general superintendence; I taught the evening school, and the science class at the institution was as it were a graft upon that evening school. I taught science for two sessions in that neighbourhood, and in the middle of the second session I applied for the post of organising master to the East Lancashire Union. During my residence at Redditch, I obtained three other qualifications as a teacher of science, in inorganic chemistry, geology, and vegetable physiology and structural botany. I was appointed as organising master in the beginning of 1865, and in November 1865 I obtained two other certificates, in organic chemistry and physical geography, and I have obtained one qualification since, in applied mechanics.

2157. I need not say that it was in consequence of the certificates which you had obtained, you were appointed organising master of the East Lancashire Union; but you have had to conduct the instruction of the science classes under considerable difficulties in the East Lancashire Union, inasmuch as your primary duties are connected with elementary instruction, and the opportunities for scientific instruction are either before or after that, and on Saturdays?—Yes, it shuts out the best part of the evening for our science instruction, consequently the pupils either have to come very early, or to receive their instruction at a later hour than is customary in other cases.

2158. Will you describe the opportunities that you have for day instruction in science?—I can give instruction in the various grammar schools in the district, or schools of a similar kind. I am not engaged in teaching in connexion with the Union till 6, and in some instances 7 in the evening. As organising master I perform the duties of assistant secretary to the Union, and consequently my only official duties during the day are those of correspondence and personal communication, and preparation for the evening.

2159. Will you state what day schools you teach in?—I teach in the Grammar School at Burnley, the only one at the present time, three afternoons weekly, for an hour each afternoon.

2160. And then you conduct the schoolmasters' class on Saturdays?—Yes, the schoolmasters' class on Saturday mornings.

2161. The scheme of the East Lancashire Union, you have already said, from the first comprised elementary instruction in science; at present are you of opinion that there would be much chance of day classes being attended in any of the mechanics' institutions?—I think it is doubtful to what extent day classes would succeed. They would have to be attended by pupils who would be the best from the several schools. I think that by stimulus a certain number could be brought together to those institutions, but if any scheme of that kind were left to originate under certain conditions with the local authorities, I think it would be a very doubtful question whether it would succeed.

2162. Will you tell us in what centres in the East Lancashire Union there exist suitable buildings and apparatus for mechanics' institutions?—At the Burnley Mechanics' Institution, and the Burnley Church of England Literary Institution, at the Haslingden Institute, and at the Bacup Institution, the buildings are all well adapted for the purposes of education, either for evening classes or for special day classes in science, as secondary schools; in fact, in one case, a school of a secondary nature, a kind of commercial school, is held in the institution at Haslingden, and in another instance an elementary school on the British school principle is held at Bacup. Those four institutions are well supplied with buildings, and they possess in the main sufficient apparatus; and being associated together, the apparatus of the Union is available for instruction in them.

2163. Has there been much encouragement given to the funds of the Union from any considerable appreciation of the benefits of science amongst the manufacturing classes of East Lancashire?—From amongst the manufacturers, as a body, there has not; in some instances, chiefly from the larger manufacturers (but those instances are few), encouragement has been given, in the way of annual subscriptions, for the last 10 years; but with regard to the great mass of the manufacturers in the district, that encouragement has not been given.

2164. If a scheme were entertained for founding in each of the centres which you have named, which possess good buildings and some apparatus, thoroughly efficient scientific classes in those institutions, and likewise in any existing grammar schools, would you expect that scheme to originate with the locality, or would it have to be suggested and promoted from some central authority?—I scarcely think that there is sufficient local interest in scientific education for such a scheme to be taken up by the persons chiefly interested in the locality. I think it would require an additional stimulus from head quarters.

2165. If, for example, you were required to give your exclusive attention to any one of those towns, and to found and conduct such classes in experimental science as would under your guidance be most efficient, would you expect any considerable amount of funds to be subscribed locally towards such an object?—No, I think that if a scheme were at the present time brought forward by the Science and Art Department, and I were looking for an appointment, I would not undertake it upon the faith of such subscriptions being forthcoming.

2166. There were two organising masters in the East Lancashire Union, were there not, and there is now only one?—Yes.

2167. Can you state on what grounds you conceive that the number of organising masters has been reduced?—The services of one have been discontinued, I may say, for two reasons; first, the inability of the several institutions, through the slackness of trade, consequent upon the cotton famine originally, to continue their annual subscription of 15*l.* per annum; and, secondly, upon the diminution in the number of subscribers and the amount of subscriptions paid to the funds of the Union.



2168. Supposing, therefore, that it were considered a matter of public importance to found in each of the centres, Bacup, Haslingden, Accrington, Burnley, and Colne, not to say Blackburn, a secondary school for the instruction of artisans and members of the middle classes in science, it must either be subsidised by the State, or you would not have any expectation of its success?—In the present state of scientific knowledge in the district, I think it would require to be subsidised in order to succeed.

2169. At one time an application was made from the Union to the Committee of Council on Education for some aid towards the salaries of the organising masters, in consequence of their holding certificates under that Department, and that aid was given for some time, was it not?—I believe it was, but that was previous to my appointment.

2170. And it was discontinued?—On reading the reports of past years, I fancy that it was continued for more than one year. I should think for perhaps three years. That augmentation of the organising masters' salary was paid in the same way as if they had been masters of elementary day schools, and in addition, I believe, a sum of 10*l.* per annum was paid to certain assistant teachers, teaching under the superintendence of the organising masters, in the same way as pupil teachers or assistant teachers teach under the day school teachers.

2171. Your remuneration is derived from two sources, a fixed salary from the Union, and the remuneration which you derive from the science classes?—Yes, I may say that my own remuneration is drawn from three sources, two public ones, and one source is of a private nature. I obtain a salary from the Union, and I obtain a payment for results from the Science and Art Department, but I also receive a certain payment for private engagements, such as at the Grammar School at Burnley, which I have not entered in the statement I have made to the Commission.

2172. There would be work in the East Lancashire Union, would there not, for several organising masters, if any attempt were made to develop the scheme to which you have alluded?—Probably for three, if all the institutions and the larger evening schools were able to adopt the scheme in its entirety.

2173. The presence of organising masters, having such an education as you have yourself enjoyed, would be very important in spreading a knowledge of science among the teachers of elementary schools, and in preparing inferior teachers?—I think so. Certainly I feel stronger upon that point now than I could have done 12 months ago, for I am perfectly astonished at the way in which the schoolmasters have appreciated my own class and the great anxiety they feel to continue it. I also see a number of other intending teachers attending the classes, and very anxious to obtain knowledge. In fact, I only yesterday received an inquiry as to whether, during the next session, I should be likely to teach such and such a subject with a view to a teacher, who is perhaps the next best qualified to myself in the district, attending in order to qualify himself.

2174. Certain allowances are made to teachers to enable them to attend lectures in London. Will you describe what those allowances are?—They are of more than one kind. There is first a standing regulation in the Science Directory to this effect, that teachers who have taught for two years consecutively, and have passed not less than 30 students each year, will be allowed second-class railway fare and 3*l.* personal allowance for the purpose of visiting London, to study points of interest to themselves in their teaching in the South Kensington and other museums, and to become acquainted with the latest progress which has been made during the year in the sciences they teach. That is independent of the special lectures, and a note in connexion with that regulation states that "special arrangements with regard to these visits may be made from year to year." For the last two years a special arrangement has been made, and last year, in addition to those teachers, special arrange-

ments were made for a number to come up for a series of lectures on light and a series of lectures on animal physiology. Then any person engaged in teaching, or about to teach, who had passed the advanced stage in acoustics, light and heat, or in animal physiology, was allowed second-class railway fare and 3*l.* if he attended one course of lectures, and I believe 5*l.* if he attended two courses of lectures in London. Those who were intending to teach, were not supposed to receive this payment till they had actually commenced the classes. The consequence was that a very much greater number of teachers were brought together last year, than those who would otherwise have been qualified under the standing regulation. Again, this year, any teacher who has passed in chemistry, acoustics, light and heat, or magnetism and electricity, I believe, and who has in addition actually sent pupils to the last examination (that is a new feature in the special arrangement) may come up on the same terms. Two courses of lectures are being delivered, one, I believe, this week, on magnetism and electricity, and another during next week on teaching chemistry.

2175. Can you point out any imperfections in those arrangements, or make any suggestions by which they might be made more effectual for the purpose of science teaching?—I believe it is a good plan in the main, as I think it is likely to bring the best methods, and the best systems of illustration, before the teachers; but I think it probable, that as each teacher who has passed his 30 students, would be allowed to come up and study his own subject in the museums, but is compelled to attend lectures on subjects with which he may have no connexion, he might be better employed. Last year several within my own knowledge went to lectures on animal physiology, who were engaged in teaching mechanical drawing, and had a very remote intention of teaching animal physiology. I think if teachers who were allowed to come to London were confined to the subjects they teach, that would be an improvement. Also I should think that a more thorough teaching of a select number of the best qualified teachers, if they could impart that instruction to classes of other teachers in their own districts, might perhaps be better; and I think this for several reasons, because when a professor is lecturing, a person imperfectly acquainted with the subject certainly loses the benefit, whereas if the professor had a number, say 20 or 30 men, whom he knew to be well up, and who required a knowledge of the methods of illustration, or the best methods of teaching, as practised in the London colleges, he would, I think, be likely to teach them more effectually than in an indiscriminate audience of those who knew the subject pretty well and those who were wishing to learn the rudiments.

2176. In your own experience, it would be of great advantage to yourself to be enabled to come to London for such a complete course of instruction in experimental science, to enable you to give such instruction to the elementary schoolmasters, or others who have only recently commenced their studies in science?—I should like it very much, but I think that such instruction, to be useful, should be more in the form of class-room work than lecture-room work. I should prefer being with a dozen, or quite a limited number, having the professor and saying, "Can you show me any better way of doing this?" and so learn it in detail, rather than sitting down with a note-book and observing.

2177. As to laboratory work, in which there has been some instruction under Dr. Frankland and his assistants, can you make any suggestion as to the classification of the persons who come up for that laboratory work?—We had a circular sent to each of us stating that we might come up for laboratory instruction, if we desired it; but having myself passed an examination in it, I thought as there would be certainly a very mixed number, some learning the merest rudiments, such as I should teach my own pupils, and perhaps one or two coming up for advanced instruction, I thought I should like to see something

Mr.  
T. W. Shore.  
5 July 1870.



Mr.  
T. W. Shore.  
5 July 1870.

more definite about it before I entered upon a week's course. I should be very pleased to have a thorough course, to see the thing thoroughly done and see how to do it; but I scarcely think that the present system would give me that assistance, for I believe that they are obliged to make two classes, one of those who know something about it, and the other of those who have only just a wish to start in the elementary details.

2178. I observe that you have obtained certificates in a very considerable number of subjects?—In 10 subjects.

2179. And having reference to the suggestion previously made, that there was work for at least three organising masters in the East Lancashire Union, would you conceive it desirable that those masters should be selected so that they could concentrate their attention upon some portions of those subjects, rather than diffuse it over the whole, so that, for example, your attention might be given to three or four subjects, rather than to 10, and another master's to three or four, and that they might thus teach them wherever required in the Union?—It is impossible, I think, for any man to do thorough justice to a large number of subjects. I have been asked myself to teach subjects in which I possess no qualification: and I have explained the fact that I cannot teach them. Of course I do not possess the qualification, and in order to become thoroughly acquainted with those subjects, I scarcely think it worth while to begin a course of study in other fresh subjects. I feel that I have not already learned all that I can learn about those I am qualified in. I therefore think, if it could be arranged, it would be very desirable to subdivide the subjects of instruction, so that each teacher might have only three or four.

2180. (*Mr. Samuelson.*) I think you are aware that the grants upon results, in respect of the examinations of the Science and Art Department, have increased very much of late?—Yes, within the last four or five years they have increased.

2181. Assuming that it should be thought that the aggregate amount of those grants could not be carried much further, can you suggest any means by which they might be limited without much detriment to the teaching of science?—The only way which I could see, under these circumstances, would be that they should be confined to places in which science could be taught with the greatest effect. I do not think that it would be desirable to spread the grant to its utmost extent. I think less good would result from spreading it, than from confining it to a limited number of the best schools, or the best localities for those schools.

2182. Would not that be creating a monopoly in favour of certain districts?—It would to some extent, but it is difficult to see how a grant of 1*l.* per annum or 2*l.* to a small school could do any good whatever. In the present case I have been thinking of an instance or two in which a teacher has opened a class, and has obtained a grant of 1*l.* or 2*l.*; perhaps he has expended nearly as much in various articles for the teaching; he is discouraged, and he shuts up his class, and very little permanent good results from his attempt.

2183. Have you looked into the Science Directory to ascertain whether there are many instances of classes being conducted for a short time only, and then being discontinued?—You will find an account in reference to the north of Ireland, where, to use the words of the report of one of the inspectors, there was quite a mushroom growth of science classes. You will see a list in one of the reports of the number of science schools which have been closed in the course of the year, and it is very considerable for one year.

2184. I am not sure whether I understood you correctly, but as I understood, you said that within the union of mechanics' institutions in north-east Lancashire you require a preliminary examination in English?—No; we absolutely require for the science classes no preliminary examination, but the organisation of the Union is designed to afford a preliminary examination to all the pupils, and the majority of

those who enter the science classes have passed it, but as a condition for entering a science class that has not been enforced.

2185. Suppose the Science and Art Department were to require a literary examination, say standard five for example, from candidates for admission to the science classes, do you think that would be a proper and reasonable means of limiting the grant?—I do not think it would interfere with the number of students under instruction, who would usefully profit by it. I think that those who do not possess that knowledge going to the examination would probably fail.

2186. So that whilst it would be a good thing in itself, you do not apprehend that it would limit the total amount of the grant?—I do not.

2187. Would you consider it to be a good thing in itself?—Standard five is an examination merely in reading, writing from dictation, and arithmetic, to the extent of weights and measures, and I think that such an examination would have very little influence upon the number of students. I think there would be still gross errors in English composition.

2188. Supposing a higher standard were adopted, for instance, the extra standard, I think it is called standard seven, would you consider that to be a good arrangement?—I think it would to some extent limit the number of students under instruction.

2189. Do you think that that would work injustice to any large class of men?—It would to many students of more advanced years, who join the classes with the view of acquiring information useful to their different occupations.

2190. Then if you were to except from that examination adults, men above the age of 21 for instance, you think there would be no hardship upon any one?—As regards the classes of the Union in which I am engaged, I think there would not be a hardship. I should myself personally be rather pleased than otherwise to see it.

2191. That men above 21 should be admitted without examination, but you would require a preliminary examination in such a standard as might be considered fair in the case of younger students?—Yes, that would do no harm. I do not recommend it, but at the same time, in answer to your question, I think it would do no harm; it would limit the number usefully, without diminishing the effective science teaching.

2192. You distinguish between the masters of elementary day schools giving instruction in science classes, and other teachers giving instruction. Can you state what are the occupations of the other teachers?—I have found 10 of other occupations. Of these 10, one is myself; another is a professional teacher at the Burnley Grammar School, a Fellow of the Royal Astronomical Society; one other is a young man about 23, who was employed as a draughtsman in a foundry in Manchester; I may say two would come under that category; one is a youth lately a warehouseman; two are assistant-teachers in schools; one is a shoemaker by trade; two are book-keepers, and one an assistant, or an articulated pupil, to an architect.

2193. Where did they get their instruction in science?—In some instances, they will have derived it from other science classes, and in one or two instances, perhaps, by self-teaching and private reading.

2194. Have you observed a tendency on the part of science teachers to abandon that occupation, and to be drafted into industrial occupations; those who are not teachers in elementary schools?—I have noticed the reverse of your statement, that they throw up their ordinary occupation, and take to science teaching.

2195. And from your knowledge of other districts, would you say that that applied generally?—I have not very much knowledge of other districts. I know of one instance in Gloucestershire, out of my district, in which a student, a painter by trade, I believe, has thrown up that and taken to science teaching; that is the only instance which, at the present time, I can think of outside north-east Lancashire.

2196. You have spoken of the change, which I



think occurred in 1867, in the requirements for obtaining a teacher's certificate, that change being the abolition of a special examination. What is your opinion of that?—My opinion has been all along that it has tended to introduce an inferior class of teachers; it increased their number, but probably diminished their quality.

2197. Do you make that statement from observation, or *à priori*?—From observation.

2198. You have also stated that the educational qualifications of some teachers in subjects 1, 2, and 3 are very moderate. Are not those subjects in which a comparatively low standard of educational qualifications may be accepted?—I think a lower standard of general education might be accepted for those subjects; but I question whether, even in those subjects in all cases, the teachers of them possess as sound a general education as would be desirable. Bearing upon your point, there is a circular which has recently been issued by the examiner of subject 1, and if you have not seen it, it would be well for the Commission to have it. It is a circular recently issued by the Science and Art Department on the result of the last examination.

2199. I see that Mr. Bradley, the examiner, states that men who in former years obtained a class, even second in the elementary stage, had, on the strength of that success, without further preparation, constituted themselves teachers of others?—I fancy that must have been a misunderstanding on Mr. Bradley's part, because it is the second class in the advanced stage.

2200. So that that statement is not strictly correct?—There is some want of accuracy in the statement.

2201. But at any rate, the general tone of that circular is expressive of disapproval of the qualification of some of the teachers in practical plane and solid geometry?—Yes.

2202. This circular refers to the examination held in the present year?—Yes.

2203. And you have noticed from the statement of Mr. Bradley that out of 3,300 candidates only 663 obtained a class in any stage?—Yes, that is so.

2204. Do you not look upon that in some measure as the natural result of the change in the teachers' qualification which was sanctioned in 1867?—I do.

2205. Have you had any conversation with the officials of the Department upon the subject?—I have had several conversations with Mr. Iselin, the science inspector, at various times; but with Mr. Cole or with Captain Donnelly, or any of the heads of the South Kensington Department, I have had no communication.

2206. Have you represented to the Department your strong opinion that this alteration was a mistake?—I have. I have here a copy of a report which I sent to the Science and Art Department after a visit, under the regulations of the Department, to Paris in the year 1867, for the purpose of studying the exhibition; and the last two pages contain my suggestions, which I shall be happy to leave with the Commission. Those suggestions are as follow:—

In offering the following suggestions, I presume, on at least, a partial aid, with a directive action from the State.

1. In my opinion it is extremely desirable that a set of books should be prepared, under the authority of the Science and Art Department, for students in science classes, or if not prepared in all cases the best text books of a suitable price already in print adopted as part of the series, and sanctioned by the Department. I also suggest that it would be desirable in some cases to have translations made of the best French and German text books, many of which, shown in the exhibition are much superior to our own, and might be used in our science classes with profit.

2. In France oral examinations seem to occupy a prominent position, and undoubtedly possess some separate advantages.

3. In the educational organization of France the greatest care seems to be taken by special training and practical examinations to ensure a high professional ability in teachers of all ranks and classes, and I believe it is a mistake to suppose that the spread of

science in England will be increased and accelerated by recognizing all the pupils who pass in a certain class as qualified for teachers. Such a regulation is the same in principle as if a minute were passed recognizing all scholars who pass standard six under the revised code as qualified for elementary teachers. It must be remembered that there are many important qualifications for the teacher's profession fully recognised by our own Department for primary education in addition to the possession of a certain amount of special knowledge, and I have yet to learn that less professional ability is required to make a good science master than to make a good elementary teacher. Such a regulation, instead of stimulating the teacher to work up to the standard of his profession, like the encouragement in France given to "Aspirants aux Brevets supérieurs ou complémentaires de capacité," is bringing the profession down to the teacher. Would not the creation of such an office as "science pupil-teacher" in schools or institutions where a number of classes are taught, be far more effective in educating candidates to become teachers? Such an office with duties, similar as far as differences of circumstances would allow, to the art pupil-teachers, would be within the reach of the best pupils, who after a course of practical work, experience in teaching, and success in specified subjects, might possibly proceed to some higher establishment to complete their qualifications; but by the present wholesale and indiscriminate system, that practical knowledge and professional skill is lost, for a candidate may be recognised as qualified to teach such a subject as chemistry, without ever having handled chemical apparatus, or even seen a single chemical experiment, for the examination required has been, and can be passed from book work only. Such an attempt to spread science among the masses, will tend inevitably to a decrease of scientific accuracy in teaching, a contempt for the teachers' office, and among artizans a loss of confidence in such teachers, the power of maintaining which should be an essential qualification. By the time science so propagated reaches the bulk of our artizans by direct, and by the indirect means which are also inseparably concerned, it requires little foresight to predict that knowledge so diffused will probably be filtered of much that is true, and adulterated with a great deal that is false. The demand is now for science applied to practice; the present arrangement has the reverse tendency, for how can practical applications be likely to be obtained when no practical tests are required, even in the experimental sciences, and even from teachers, the *vivâ voce* examinations and practical chemical analyses being now all abolished.

4. I suggest that it would be desirable to grant to science masters a general diploma, like the diploma granted in France for "l'enseignement secondaire spécial," to obtain which it should be necessary to pass an examination in a certain number of specified subjects and other optional ones. In France the teachers receive a special training in the "École normale de Cluny," for admission to which a certificate of sound primary knowledge is required, and the candidate has to pass a general written examination and an oral scientific one. For the "Brevet de capacité" as a teacher of science, he is required also to pass a general scientific examination, both oral and written, and to give practical proof of teaching ability. A general diploma would ensure the science master to be a man of sound general scientific culture, which the present regulations ignore, for teachers may be recognised not only deficient in scientific knowledge, but also in general elementary education. It would also enable him to teach any subject within a certain range, without any interference with the qualifications of teachers holding special certificates.

5. On the walls of any of our schools of art we see results of the students work in art from various localities. Why should we not see also in our science schools practical proofs of our scientific teaching? I think a great deal towards accomplishing this might be done by supplementing the present scheme with premiums and prizes for practical work and applications, carried out by the pupil under the direction of the science master, such as—

(a) For specified models in wood or iron of machines, engines, or parts of them, or for models illustrating the conversion of the mechanical movements. (b) For constructions of apparatus for illustration and application of the physical sciences. (c) For skill in chemical testing and analysis; and for good preparations of various salts, &c., capable of formation in an ordinary laboratory. (d) For *bonâ fide* collections of geological specimens of rocks, fossils, &c., within a certain radius

Mr.  
T. W. Shore.  
5 July 1870.



Mr.  
T. W. Shore.  
5 July 1870.

of the science school. (e) For bonâ fide collections in natural history within a given radius of the science school. (f) For modelling of natural history specimens. (g) For geological sections, neatly drawn, sections of mines, relief maps, or models of a district within a certain radius.

It is difficult to find any establishment for the scientific instruction of workmen in France, where collections of models are not used with examples constructed by the pupils, and, from experience in teaching the experimental sciences, I know that the construction of apparatus and scientific appliances is often a favourite occupation of pupils. Though such rewards could only be earned by the best science pupils, yet I think it would be possible in a larger development of the scheme to encourage practical work of a lower kind by visits of sub-examiners two or three times a session, like the district inspectors of national schools in Ireland.

Excellent models from continental technical schools were shown in the exhibition, among which, from Austria, was a school museum, and I believe there is a vast amount of latent energy in England capable of being drawn forth by such a scheme as I have described. The best models and collections could be purchased by the Department and distributed among the provincial schools. Every science school might then in a few years, hope to possess decent collections illustrative of English natural history and geology, the construction of machinery and philosophical appliances. Our science schools would have more to show in claiming to be recognised as sources of technical instruction, and in addition to the increased direct good they would do, there would be a large amount of indirect teaching by the existence of such collections on occasional visitors. In large towns such educational collections might be developed into provincial museums, and become in themselves educational agencies of a most desirable kind, seeing that many of our local museums at present are but imperfect curiosity shops. What I have now sketched out in offering this suggestion, would only be carrying out, in education, a principle on which most commercial matters depend. We create during the first periods of educational labour a kind of educational capital, and so surely as it exists will this accumulation of the labour of former pupils help to educate their successors.

6. The attempts hitherto made by England for the diffusion of scientific knowledge seem, in contrast with those on the continent, wanting in special direction and completeness, and from what I have seen and learnt from the Exhibition and from France, I feel that one of the most important suggestions I can offer to the Department is the desirability of giving to the efforts for the spread of science more connexion and more special direction.

It appears to me that facilities for gradual instruction in science should be offered to the artisan population from the elementary schools upwards. In the period before the introduction of the Revised Code of Education, certain grants of apparatus, amounting to two-thirds of the cost of simple collections specially prepared, were given to elementary schools, and teachers were encouraged to instruct their elder scholars in the elements of science. The Revised Code practically abolished this special teaching, by confining schoolmasters chiefly to reading, writing, and arithmetic, and the scheme of the Science and Art Department has not fostered what it thus seemed previously to have been the intention of the Government to encourage, for, in addition to the science scheme requiring a much more comprehensive knowledge, the regulations of the Department insist that the instruction in science must not be given during the ordinary hours the elementary school is open. This plan for adding the simplest instruction in science to our elementary schools possessed, I think, many advantages, and I suggest that in making a more complete provision for the scientific instruction of artisans, encouragement should be offered for this special teaching of scholars who have reached the highest class of the elementary school and have passed standard 6 (and in most schools there are a certain number), by a return to some such plan. This would necessitate an increased attention to science in training schoolmasters, an attention by no means undesirable, and the results of such a scheme might be tested by an examination in the ordinary course of inspection more elementary than the essay paper given to science classes, or orally by the visits of sub-examiners in science. It would also prepare some pupils, at least, to enter the more advanced science classes, by which the work of science masters would be greatly facilitated, and, in the event of the establishment of technical schools, the first rudiments

of science imparted to the highest classes of the elementary school, by means of its little chemical laboratory or collection of simple philosophical and mechanical apparatus, would be very valuable as preparatory to the special teaching, and if exhibitions were offered to the most successful of such pupils, like the "bourses" awarded in France, these appendages to our elementary schools would feed the technical schools.

7. For a thorough and comprehensive system of instruction in science and art, such as the exigencies of the times and foreign competition seem to demand, presupposing a sound primary system of education, we require, I think:—1. The introduction of rudimentary teaching in science and art to the highest classes in our best elementary schools. 2. A fuller practical development of the present scheme of science classes in connexion with mechanics' and other institutions, which I have previously suggested. 3. The establishment of trade or technical schools in large towns with a sufficient staff of masters and practical teachers for instruction in applied science and art, as exemplified by the trade of the district. 4. The foundation of provincial Colleges of Science where teachers may be trained for science masters, and a first-class scientific education offered to other pupils, as carried out in France at the "École Normale de Cluny," and proposed in the programme of the new College of Science at Dublin; whether any existing educational establishments for training teachers could be diverted for this purpose is, I think, a fair question.

One of the first steps towards making the instruction in science more directive and applicable appears to me to be the establishment of more connexion between the instruction in art and the instruction in science. Art and science are closely connected as far as the wants of our artisans are concerned, and I think there can be little doubt that greater good would result from a connected teaching of both, than from disjointed efforts.

With a view to these suggested improvements, would it not be possible in some instances to associate science schools in the same establishments as art schools, and might not a greater encouragement given to such a connexion tend, in places where art schools are not too flourishing, to place both on a firmer basis, and make them more likely to attract support?

For the establishment of more connexion in science teaching, might not the formation of unions for scientific instruction be practicable on a plan somewhat similar to that recommended for art teaching, and as carried out for elementary and scientific teaching by the East Lancashire Union of Institutions?

With regard to the question of technical schools, the necessity for which I assume to be already proved (considering that the interest which religious and other voluntary bodies take in the furtherance of education is in most cases confined to elementary schools, and the poor success which has attended voluntary efforts to establish mining and trade schools), might not the State in these cases depart from the voluntary principle on which our present educational organization rests, and, taking the initiative in establishing such schools, commit their management to corporate and other bodies of practical men? In some cases, perhaps, "The Public Libraries Act, 1855," might be sufficiently elastic for this purpose. Such establishments, in my opinion, ought not to be constructed solely on any one type, but to be adapted to the special wants of particular localities.

2207. You spoke of the present as a favourable time for establishing classes of schoolmasters; you allude there, I suppose, only to such classes as you yourself have established in North-east Lancashire?—I derived the idea of a schoolmasters' class primarily from the fact that they had been in existence in Leeds in the previous year. Knowing Mr. Sales, of the Yorkshire Union of Institutions, I had several conversations with him upon the matter, and from conversation with several members of the Council of the East Lancashire Union also, I came to the conclusion of trying it in our district, and I recommend classes of that nature.

2208. You recommend them, I suppose, because you have to deal with schoolmasters who are already formed. That would not be the natural course of giving instruction to schoolmasters. You would not adopt that course with respect to other subjects with the teachers?—None of the 12 schoolmasters who have attended my classes had any qualification in science. I should open that class to those also who have any other subject which they may be qualified in.



2209. Would you not consider it more desirable that they should have obtained that instruction during their preliminary training?—Undoubtedly; and the class of schoolmasters has, in the district of Burnley, acted as a remedy for the want of that training.

2210. Just as night classes for adults are a remedy, and generally an insufficient remedy, for the want of elementary training during childhood?—Not precisely; for adults certainly, but evening classes for youths I think possess a value independent of elementary day-school education.

2211. Have you any knowledge of the amount of scientific teaching which is now given in the training schools?—I think it is but small, because necessarily they are obliged to keep to the curriculum of the training college as laid down by the Whitehall Department. Physical geography, animal physiology, and mathematics are the usual subjects, I believe.

2212. Then any classes beyond those which would not form part of the curriculum of a training college would be, under the Science and Art Department, separate classes?—I believe so.

2213. Has any complaint been made on the part of the authorities of training colleges as to the restrictions imposed on them by the Committee of Council on Education?—I am not aware of any.

2214. You have stated that the older teachers are now endeavouring to qualify themselves to compete with the younger men, many of whom have some knowledge of science?—Yes.

2215. And you have suggested that it is a loss of time and labour to examine certificated teachers in stage I. of mathematics, because they have passed an examination in that subject on receiving their certificate?—Yes.

2216. But is it not the case that from disuse many of those teachers may have lost the knowledge which they at one time possessed?—I scarcely think they would have lost the knowledge up to stage I. of mathematics, because if they have pupil teachers their pupil teachers would possess it.

2217. So that they would not in fact have lost the habit of teaching up to that stage?—I scarcely think to stage I.

2218. You have spoken of a general diploma for scientific teachers when passed in a number of subjects; have you considered at all what the qualifications for that diploma should be; can you go into detail upon that subject?—If I went into detail, it would be more by way of a diploma for experimental subjects, another for subjects in natural history, and so on. I can scarcely recommend that there should be a number of examinations for men to become qualified teachers of any one of the 23 subjects; in such widely different subjects, for instance, as navigation, botany, and so on.

2219. You would group the subjects?—Yes, I would group the subjects.

2220. Would you, in addition to that, have a special examination before giving a diploma?—I think that teachers should have a special examination. I think that a professional teacher, unless he had already an elementary certificate, should pass such an examination.

2221. Seeing that you think it desirable to give some additional encouragement to teachers of science, would you consider this a good mode of encouraging them, that those diplomas should carry with them some small annual stipend?—Yes, while engaged in teaching; that was the original scheme of the Department.

2222. Which was abandoned in what year?—In 1862, I think.

2223. But at that time, I believe, the mere possession of a certificate in any one subject entitled the holder to some annual grant, did it not?—Yes.

2224. That would have become very onerous if it had been continued?—It only entitled them to it during the time of teaching.

2225. Have you considered the question of the creation of a special college for training teachers in science?—I have not considered it deeply. I alluded to it in that representation which I made to the Department; I said I thought it desirable.

2226. Do you consider it essential?—I suggested the appointment of young persons in the best science schools, in positions corresponding to the pupil teachers in art schools. I suggested that they should be taught under the science masters, and that they might then proceed to some higher establishment to complete their qualification. I suggested also that it was, I thought, a fair question whether any present educational training college might not be diverted to that purpose. I see at the present time that one training college is bringing forward its opportunities as a technical college.

2227. Those colleges are all denominational, are they not?—All the Church of England colleges are denominational, and all connected with the British and Foreign School Society are semi-denominational.

2228. Your classes having now been established for about five years, the time has arrived when it may be possible for you to judge of their effect upon the artisans of your district, can you give the Commission any information upon that point?—I cannot give information except in isolated instances. I see cases of artisans improving their social position by a knowledge of science; I see a very great desire among a limited number, who have been in the classes for a number of years, to still further improve their knowledge of science; and I have observed a tendency among such pupils to act as centres of information for their fellows. I cannot speak with any certainty upon the present effect of the system of science teaching upon any one industry; but I have observed those three points.

2229. Do I understand you to say that the tendency of the science teaching has rather been to lift artisans out of the artisan class?—Certainly not, as far as my observation has gone. I think it has tended to improve the character of them rather than remove them. There may have been instances of artisans being lifted from the artisan class by science teaching. I have seen one or two instances; but in a general way it has acted upon the life of the man; upon his value as a workman, I mean.

2230. On the whole you have not observed that in those instances, where their social condition has not been raised, it has made them discontented with the station which they occupy?—No, I have not observed that it has made them discontented. They have sometimes migrated to obtain better appointments, but I have not observed any discontent.

2231. Is the apathy amongst manufacturers of which you have spoken to be accounted for by the fear that a higher education might make the artisans discontented with their position?—I cannot say; I do not know very much of the manufacturers as a body. I think it is possible in some instances, but I should not like to give a definite opinion upon that point.

2232. At any rate if that were so you would consider it to be quite a groundless fear upon their part?—I should, and probably that fear would arise from the want of a relative amount of education amongst the manufacturers.

2233. You think that they are not themselves alive to the value of science in their particular pursuits?—Not as a whole. There are instances of it of course, but in the main I believe that the manufacturers are not alive to its importance.

2234. What are the industries which are special to North-east Lancashire?—There is the staple industry, the cotton manufacture and print works, dyeing works, chemical works, mining, foundry work, and machinery manufacture.

2235. Improvements are constantly being made, are there not, in those different branches of industry?—Yes.

2236. Do you come sufficiently in contact with manufacturers and those engaged in mining to know by whom those improvements are chiefly made?—No, I do not come in contact with men from whom I could form an opinion upon that point; my knowledge is chiefly from private reading.

2237. You have no special knowledge?—No.

2238. You have stated that little encouragement

Mr.  
T. W. Shore,  
5 July 1870.



Mr.  
T. W. Shore.  
5 July 1870.

would be given to the establishment of secondary science schools in your locality, but is it not the case that mechanics' institutes have been founded and sustained in that locality by local efforts?—They have, but I think scarcely by the bulk of the manufacturers.

2239. The burden of the maintenance of those institutions has fallen upon a few?—Yes, and upon the bulk of the artizan population. I can instance, at the present time, artizans in my own classes, contributing half a guinea, a guinea, and two guineas each towards the improvement of an institution.

2240. Is it impossible that secondary schools could be based upon support of the same kind, partially at least?—I think it might, to a limited extent, but I think, certainly, you could not rely upon that amount which would be necessary under the regulations, as at present existing, for conducting them.

2241. There are several large towns within your district; will you kindly state the population of some of them, Blackburn, Burnley, and Accrington, for instance?—The population of Blackburn is from 65,000 to 70,000, Burnley 45,000, Accrington 20,000 to 30,000, and Bacup 18,000 to 20,000.

2242. And in all those towns the only secondary school in which you have obtained employment as a science teacher is the grammar school of Burnley?—Yes.

2243. Do you know whether any other gentlemen are employed as science teachers in schools within the district?—There is another school which comes under the grade of a secondary school, in which a pupil of my own teaches: it is a private school, of which his father is the proprietor, and he teaches science in it in Burnley; that is the only instance I know.

2244. In Blackburn have you such schools?—I know of none there.

2245. And you do not believe them to exist?—I believe not.

2246. (*Professor Huxley*.) I wish particularly to ask what is your opinion upon a very important matter, and one which goes to the root of the entire working of the whole system of examination, that is, the existence, so far as your knowledge extends, of the system of preparing candidates for examination for the mere sake of what is to be got by payments; that is to say, you may be aware that it comes under the notice of the examiners, that a very considerable proportion of candidates are sent up every year from particular schools, who are clearly not taught, but simply crammed for the purpose of examination; have you had any knowledge of that taking place within your own observation?—When the whole result depends upon a written examination there is necessarily more or less cramming. I have seen in some instances, even amongst my own pupils, a tendency to that. I never recommended it, I have rather discouraged it; but there exists, whenever there are results upon a written examination, an inseparable tendency to cram.

2247. Cram is of various kinds, there is good cram, and there is bad cram; but have you seen anything like the cases which have come under my own observation, for example, of perhaps a class consisting of 70 or 80 or more candidates, and out of that number seven-eighths or nine-tenths, or even more than that rejected for absolute ignorance; have you known anything at all like that in your own district or neighbourhood?—Through cramming up, if I understand you rightly, questions which the examiners do not put.

2248. Not at all, but through not knowing the most elementary facts; obviously a number of children, who could hardly write or spell, crammed with mere verbal information about matters of science?—No, I have known nothing of that.

2249. You may be aware, however, that some of the examiners have made some strong representations about it?—I am.

2250. Can you suggest any means by which the recurrence of the abuse of the encouragement given by Government of that kind could be prevented?—I see no remedy for it, unless on the visit of the science inspector an oral examination be held.

2251. Of course there is one check so long as the

examiner does his duty, which is in the extensive rejection of persons prepared in that way, but even that throws a greater burden upon the State, because all rejected papers have to be examined?—Yes, certainly.

2252. Then do you think that periodical examination by an inspector would tend to remove this evil?—On the visit of the inspector, if his inspection were more in the nature of an inspection of an elementary day school than of a mere formal visit to inspect the registers, he would be able, if he were a scientific man acquainted with the subject, to see whether the candidates were really being crammed, or whether they possessed an intelligent knowledge of the subject as far as they had gone.

2253. Then the inspector should visit the classes while the teaching is going on, should he not?—Yes; in order to do that he should, of course, come in the course of the session; but so far as my observation has gone, he has never asked questions of the science class except that Mr. Iselin, I think, has once or twice done so.

2254. Such an inspector would require to see that something like a demonstration of the subjects talked about took place?—Yes.

2255. Do you think that the previous examination of teachers, that is to say, compelling a teacher to take a certificate in the science that he professes to teach, would be likely to have any effect in checking this sort of cramming to which I am now referring?—I think if the teacher's examination were raised, if greater qualifications and more practical knowledge of his subject were required of him, he would be more likely to reproduce it in his pupils.

2256. It has been stated in evidence here that some of the worst cases of the kind of cramming to which I refer have come from the teachers who were examined and had certificates under the old system. You have mentioned in the course of your evidence that there is a tendency in the Science and Art Department to subdivide the subjects of examination; will you be so good as to explain exactly what you mean by that?—I believe, that in the scheme of the Science and Art Department as originally established, the subjects were arranged in sections. Section 1, section 2, and section 3, up to about, I think, section 6. Several other sections were added successively in various years, and the scheme was about 1865, I think, put into a new form entirely. The list of 23 subjects was taken much as they now stand. Mathematics was inserted, but in the year 1859 the teachers were examined in experimental physics as one subject, and that was subdivided. I am not quite sure whether chemistry was not subdivided in the same way, and mechanical physics in the same way. Mathematics was inserted before theoretical mechanics on the recommendation, I believe, of Professor Cowie, with the view of improving the teachers passing through it before going on with theoretical mechanics, and so, partly by subdivision and partly by addition, the list has grown.

2257. But there has been no change for the last five or six years, has there?—The recent change in mathematics only.

2258. You are doubtless aware that in several subjects there is now a rule which they enforce as far as they practically can, that a candidate shall not come up for the advanced stage, unless he has previously passed in the elementary stage; do you think that a good rule?—Except in exceptional circumstances, like teachers qualifying themselves, I do.

2259. Do you think that that contributes to prevent the time of the examiners being wasted by persons who are not competent to take the questions which they do take?—In many instances I do think so.

2260. Is there any suggestion that you have to make with respect to the examiner's recommendations for making the teaching more practical? You mentioned that certain changes have taken place which you thought were beneficial, but you did not say whether you thought that the system could be further developed with advantage?—I anticipate that a great improve-



ment will result from the recent minute on chemistry. I think there is certainly an improvement in the teaching of animal physiology this last year, as far as my information has gone with reference to the limited number of classes that I have any knowledge of. I think that thorough practical lessons in teaching to the teachers, or to those who are most largely engaged in teaching, would tend greatly to improve the character of their class lessons.

2261. I imagine that a great deal of the difficulty which teachers meet with in sending up their candidates properly prepared, arises from the circumstance that the subjects which hitherto teachers have been taught to teach have been almost wholly book subjects?—Probably.

2262. In fact it is very much the case at any rate that teachers of any standing who now begin to attempt to teach science, try to deal with it as if it were book work, and fail in consequence?—I do not think they all do.

2263. Not all, by any means; but that frequently happens?—Those who come up by private reading only very often do fail.

2264. But is it not the case with teachers who attempt to teach science without having some preliminary instruction in teaching physical science that they attempt to do it too much from books and mere thought?—As far as my observation has gone, it is. Some also teach subjects I., II., and III. largely, by means of copies which correspond, I imagine, to book-work in physical science. Professor Bradley makes the remark of subject I., that in all probability the pupils have been engaged in simply copying mechanically.

2265. Take for example my own subject; do you think that teachers not unfrequently attempt to teach, we will say the circulation of the blood, and they never dreamed of showing the pupil such a thing as a sheep's heart, or anything that would enable the boy to realise what the teacher is talking about?—It was commonly done formerly, I believe, with illustrated diagrams.

2266. But being content with mere diagrams?—Yes, formerly.

2267. You mentioned in the course of your examination that it was desirable that there should be a low standard for the mere pass or first success, is it not a fact that at present the candidate can pass in the second class an easy examination with a very low standard of knowledge indeed, and do you think anything lower than that would be worth paying for?—Not paying the amount. I think there might be a lower pass still, or a lower test still with regard to day schools, than the elementary stage of science classes.

2268. Do you think that that would not degenerate into a mere system of, I was going to say, outdoor relief to teachers?—It might be made dependent upon certain conditions, as the grants at the present time to elementary schools, such as the drawing grants.

2269. But having regard to what is paid for instruction now, and what you have just said, you do not think that the standard is pitched too high to allow a candidate to pass in the second class of the first examination?—I think the standards vary, that is to say, I think candidates may pass more easily with the same amount of work in some subjects than in others. I have seen candidates obtaining second classes surprised that they are there, and I have seen others who have failed surprised at not being first-class men, and with reason in both cases.

2270. But I have no doubt that you are aware, from your experience as a teacher, that people who do fail in getting what they expect, have very rarely a just estimate of their own knowledge?—In some cases that I have seen I have really sympathised with the candidate.

2271. Have you seen the papers under those circumstances?—No, but I have held test examinations.

2272. But no doubt you are aware that in the

course of an examination it is quite possible that by chance a student shall fail to know the particular thing which he happened to be asked upon that occasion?—Yes.

2273. What is your opinion as to the age at which any branch of physical science can be commenced to be taught with advantage to such pupils as you are in the habit of dealing with?—I think it may be commenced even earlier than I commence at.

2274. At what age do you commence commonly; I think you say from 16 to 20 years?—Yes.

2275. But you have not mentioned in the course of your examination how early you think it may be commenced?—That would depend upon the nature of the instruction to be given.

2276. Take such a subject as physical geography, which is capable of being taught to very young people if it is properly taught, how early would you begin?—I think that all the great principles of physical geography might undoubtedly be taught to boys in the day school at 10 years of age.

2277. A good many elementary facts of physics may be taught, may they not, to young children?—Yes, but it never would be in the form in which the scheme of the Science and Art Department is arranged. I would not undertake to teach children under its requirements. I would go into a school and give a lesson on air, or a lesson on water, or a lesson on the pump, and so on, teaching scientific principles from common subjects.

2278. Is that now done in primary schools?—It is not done now to my knowledge; it was done previous to 1861, but the Revised Code swept it away. There were grants then given for the very purpose of the teaching that I am talking about; teachers were invited to come up for those small grants of apparatus that I have alluded to.

2279. Was that before 1859?—Yes, before 1859; even so long ago as 1855 and 1856 I remember it. The Science and Art Department, in 1867, created what is called the elementary school scholarship of 5*l.* per annum, but the Government had previously swept away the very machinery which would have created pupils to take advantage of the scholarships, and as far as my observation has gone that minute has been next to a dead letter. If they had continued those small collections of physical or chemical apparatus in schools they would have helped to feed the science classes, and a great deal of work has now to be done over again which would have been done then in the ordinary course of things. I could take you into schools in which you could see the remains of those collections where they have been for 15 years.

2280. It is within your experience then that before 1859, when the Science and Art system was introduced, those subjects were taught in primary schools under the authority of Whitehall?—Yes, and I applied for an examination myself in 1861, and I was told that since the Revised Code it was passed over to the Science and Art Department. I went there, and with a great amount of study succeeded in taking from the Department what was really of no use to me for two years, for I had pupil teachers, but had the previous system been continued I should have gone on, and taught science in the day school in which I was a master.

2281. But at the same time that this system of science was introduced into the day schools it was not permitted that special instruction in evening classes should be given?—No, there was no scheme brought forward at that time.

2282. It was not really a new scheme, but when the Science and Art Department's scheme was introduced, the teachers, under the authority of Whitehall, were forbidden to have anything to do with the Art Department?—Yes, unless they had permission. I remember very well at the time I first commenced teaching, the school managers had to write to the Whitehall Department to obtain that permission, and it was granted, as I had a second certificated master as an assistant.

Mr.  
T. W. Shore.  
5 July 1870.



Mr.  
T. W. Shore.  
5 July 1870.

2283. So that in practice it comes to this, that the one department was encouraging the teaching of science in primary schools, and the other discouraging it?—That was so in fact.

2284. That must have been after 1859, because the present science and art system was introduced in 1859?—The education department encouraged the humblest teaching of science previous to 1861. The Science and Art Department commenced encouraging it in 1859, and they acted, I imagine, with the elementary department for two years, till 1861, and then the one discouraged it and the other pursued it. I think from 1859 to 1861 classes might have been held at Mechanics' Institutions as well as in day schools.

2285. I judge from your evidence that you consider that very considerable harm is done to the prospects of scientific teaching in the country by the incessant changes which are going on, especially in the rate of payment to schools?—Yes, and the want of confidence which is engendered by sudden changes of all kinds. Many would commence studying with a view of teaching these subjects, but they have no great faith in the continuance of the scheme.

2286. When you say sudden changes of all kinds, you can hardly mean to refer to the scheme of science examination, because that has only undergone a very slow and gradual development?—I allude to the changes in the educational system of the country generally in both departments. This want of confidence began at the period of the Revised Code, and it has grown since with each additional change. So long ago as 1864 I remember trying to encourage an old schoolmaster of great experience, and a capital teacher, to go in for these subjects, or some of them, and he said he had no faith in their continuance.

2287. The introduction of the Revised Code was regarded, whether rightly or wrongly, by the great mass of the teachers in this country as a breach of faith, was it not?—As far as my observation went it was. (*The witness handed in the following table.*)

The witness withdrew.

## SCIENCE SCHOOLS IN NORTH-EAST LANCASHIRE.

School.	Number of Subjects Taught.	Number of Certificated Day School Teachers Engaged.	Other Teachers.
Accrington - Mech. Inst. -	6	2	—
Wes. School -	3	1	—
Christ Church School.	1	1	—
Bridge Street	3	—	1
Bacup - Mech. Inst. -	6	—	2
Wes. School -	1	1	—
Burnley - Mech. Inst. -	8	—	2
Literary Inst.	7	—	2
Grammar Sch.	2	—	2
Carlton Road School.	2	—	2
Schoolmasters Class.	1	—	1
Church - National Sch.	3	1	—
Colne - Grammar Sch.	2	—	1
Crawshawbooth Mech. Inst. -	3	—	1
Great Harwood National Sch.	1	1	—
Haslingden Institution	5	—	1
Nelson-in-Marsden -	4	—	2
Oswaldtwistle - Wes. School -	2	1	—
Busk School	1	1	—
National.			
Padiham - National Sch.	3	—	1
Wes. School -	2	1	—
Rawtenstall - Mech. Inst. -	4	1	—
Irwell Inst.	3	1	—
Blackburn - Wes. Sch. -	5	1	—
Town Hall -	3	—	1
Church Inst. -	1	1	—

N.B.—More complete information concerning these classes will be contained in the Report of the Science and Art Department for 1869–70 (not yet issued to the schools).

W. W. Smyth,  
Esq., F.R.S.

WARINGTON W. SMYTH, Esq., M.A., F.R.S., examined.

2288. (*Chairman.*) I believe you are professor of mineralogy and also professor of mining in the School of Mines?—I do lecture on both those subjects.

2289. You are also examiner in those subjects under the Science Department at South Kensington?—Yes, I have been so from the commencement.

2290. Has the number of candidates in those subjects increased at the Kensington examinations?—It has increased, but not largely. I think on the average, from about 30 candidates per annum to between 60 and 70 in each of those departments.

2291. Mining was added as a separate branch subsequently to the establishment of those examinations, was it not?—I was requested in the year 1861 to prepare papers on mining for artisans and their sons above 12 years of age, and for the examination of any other persons who wished to compete for the prizes, in consequence of an application to the department by certain ex-students of Jermyn Street, who had been giving instruction to their classes in the country upon this subject of mining.

2292. Is mining now a separate branch from mineralogy in the South Kensington examinations?—It is entirely separate.

2293. What are the proportions who pass in the two subjects?—The number of candidates in mineralogy was 63. One entered for honours who was not passed; 12 for the advanced paper, of whom two were rejected; and 50 for the elementary paper, of whom 14 were rejected. In the principles of mining we had 64 candidates, of whom four proposed to pass in honours, but did not pass; 27 took up the advanced paper, and of those 15 were rejected; 33 took the elementary paper, and 18 were rejected, being more than 50 per cent. in those classes rejected in mining.

2294. The numbers are not very large in either of

those subjects. Can you give any reasons why you think the numbers are not larger?—I think that the interest in the subjects is in a great measure restricted to certain districts, the districts in which mines are situated; and more especially with regard to the second subject, mines, it is very difficult to obtain proper teachers, mere book learning being very insufficient. There is another difficulty in this respect, that there are very different requirements in different districts in the country; what suits the coal district of Durham, for instance, or Lancashire, being totally unsuitable to a district like Cornwall, or Devon, or North Wales.

2295. You do not think it advisable that the number of subjects should be multiplied too largely in general schools?—I think it is scarcely desirable that, for example, my own subjects should be looked upon as subjects for the elementary schools throughout the country, but they should rather be restricted to certain districts in which their practical advantage comes out more strongly.

2296. Are those subjects attempted in any districts in which favourable circumstances do not exist for giving instruction in those departments of science?—I am scarcely aware where the papers come from, but in some instances they seem to be so, some of the answers being of a very theoretical character.

2297. You think that such a subject as mineralogy can only be taught with advantage in certain districts?—I think that it can be taught with advantage only in cases where they go somewhat beyond the elementary schools, and where boys are likely to remain at school after the age of 12.

2298. Are you of opinion that in some districts much good has resulted from the examinations?—I have been struck with the improvement in the character of



the answers sent up to my questions in both subjects. I should have had my doubts as to the advantage of putting questions on the art of mining, but for the fact that, accidentally, I have been brought in contact with young men, both in the north and in Lancashire, and in some of the mining districts in Cornwall, who, I have found, have grouped themselves together in classes for the purpose of working out the subject themselves, in order to be able to attack those examination papers of South Kensington. They seem to have devoted their evenings to it, and it has taught them to think, and to reason, and to observe upon a number of points which I think they otherwise would scarcely have paid close attention to.

2299. Are you of opinion that technical schools for the teaching of those subjects are needed, and cannot be established without aid from Government?—They are certainly very much wanted, and one great difficulty about their support is, that they are necessarily connected with more expense than the elementary schools in large towns, and it is almost indispensable to take the means of teaching to a number of villages or outlying small towns.

2300. Is Government aid given to any schools of this description except in the way of payment by results?—I believe not.

2301. What are the technical schools which you have principally in your mind?—One of those which I have seen myself is at Truro, which was tried for some years, and at which I assisted as examiner from time to time, and another one at Bristol, in which I have assisted in the same way; and one in Cornwall, which is called the Association of Miners of Cornwall and Devonshire, I have been a subscriber to from its commencement, one that forms classes for a number of different localities in Cornwall.

2302. (*Mr. Samuelson.*) Is that the same as the one at Truro?—No; that has for years been closed, or it has been to some extent transferred to this mining association. One was started at Glasgow, in the Andersonian University, but that class has unfortunately failed. The Mining Association of Cornwall has head-quarters at Truro, but classes are held at St. Just, at Camborne, at Breage, and several other places wherever the young miners are able to get up a class. I may add that at Newcastle an attempt has been made quite recently to get up classes which should be in connexion with the South Kensington examinations, and which should be accessible to young men at Hetton, at Elswick, and many other places in the neighbourhood of Newcastle; but in consequence of an alteration in the South Kensington arrangements for payments, the committee of the Mining Institute of the North of England, who have taken it into their charge, are very much afraid that the whole will break down. They have succeeded in the course of two years, during which they engaged one of our former pupils, Mr. Rowden, to be teacher, in educating to a certain point, that is to say, in teaching several hundred students; but they say at the present moment that they are rather doubtful about ultimate success from the want of funds. The chief reason, I believe, is, that a teacher can with greater facility get together large classes, and make a good income out of them, by remaining in the large towns, whilst he finds that his visits to those actual centres of mining operations are coupled with too much expense to allow them to be remunerative.

2303. Are the employers unwilling, as a rule, to give much assistance?—No; in this case it is principally the employers who have acted as a committee for encouraging the system.

2304. (*Sir J. Kay Shuttleworth.*) What amount of encouragement, in the way of pecuniary assistance, have they given?—I am not acquainted with the particulars. I should say that I have obtained some information upon this point from Mr. Daglish, the late viewer to the great Londonderry collieries, who has all the information at his fingers' ends, as being on the committee, but the committee have not made public, as yet, the statistics of the matter.

2305. (*Chairman.*) Do you think that technical

schools ought to be connected in any way with primary schools?—I think that in some of the country places it is perhaps difficult to divide them altogether, in some instances they are obliged to be placed under the same roof, but I think that those applied subjects ought not to be forced upon the primary schools intended for young boys.

2306. Do you contemplate their being conducted by the same master?—In some instances I believe it may be done; but in other cases, as, for example, has taken place at Bristol, for a number of years together there was an excellent mining school attached to a trades' school, in which some of the subjects have been taught by a general master, and other special subjects, such as mining-machinery, and the art of mining generally, by a special master.

2307. (*Mr. Samuelson.*) That trade school at Bristol is something very different from an ordinary elementary school, is it not?—It is so.

2308. (*Chairman.*) Do you think that there is much difference in the amount of schooling which the various classes of agents and workmen ought to receive?—I think it is so very different that it constitutes one of the difficulties in the whole matter. With a workman a comparatively small amount of education alone can be expected; but with the intermediate class of the overmen, or captains, as they are called in other districts, a much higher grade of education would necessarily be required, and then for those who have the chief management of large works a still more scientific training is desirable.

2309. Might not the education of all classes be conducted together up to a certain point?—I believe that might be so in many instances, at all events.

2310. Are any defects likely to spring up in local schools which can be counteracted by the existence of a central school?—Yes. That comes out very distinctly in the papers which are sent up to South Kensington, showing that the tendency in the local schools is to localise their studies very much; for instance, for the school at Wigan to apply itself very exclusively to matters with which the teachers there have become familiar; whilst if we take another distant district like Cornwall, we shall find that they object almost to questions which have reference to subjects of investigation in other districts, and therefore a general knowledge of processes, and a broader view of the subject can only be acquired, I think, by keeping them in connexion with a central establishment.

2311. Have you yourself any proof of this in the letters that you receive with respect to your lectures in Jermyn Street?—For several years I have been troubled with a great number of letters in consequence of some technical papers, like the "Mining Journal" and the "Colliery Guardian," sending reporters who have reported my lectures at great length, and people in the different mining districts read them, and they send up to learn whether they cannot be supplied more fully, whether the entire substance of the lectures cannot be supplied to them either by the newspapers or by myself, and I have received so many letters on the subject that it really at times a little hampers me in my other occupations.

2312. Does your remark, as to the narrow views which are imparted in so many of the local schools, apply equally to mineralogy as to mining?—Not so much so, that being really a branch of science, whilst the other is a group of applications of various sciences.

2313. Do the answers that are given on the mining papers seem to show that in many schools they have no idea that mining differs at all in different districts? Do they seem to imagine that one district is exactly like another?—In some instances it is so, but it is more generally the case that they are apt to pick out certain questions in which they show that they have studied pretty closely the conditions of their own district, but are really very ignorant of those of other districts; and with regard to the methods applied for working, and the varieties of machinery, the same sort of partial view comes out very distinctly.

2314. Can you state to the Commission the origin

W. W. Smyth,  
Esq., F.R.S.

5 July 1870.



W. W. Smyth,  
Esq., F.R.S.  
5 July 1870.

of the separate courses which you are in the habit of giving at Jermyn Street?—When the late Sir Henry De la Beche first proposed to turn to some useful account in education the various collections which had been made by the survey and were deposited in the Museum of Economic Geology, he suggested that I should, during the winter, give the students a course on what he termed mining mineralogy, which was to illustrate the collection of ores and of vein stones which had been made during the progress of the geological survey; but on coming to think it over, it was obvious that the science of mineralogy required to be given as an independent subject. Then I proposed to add to that a more technical course on the art of mining, which should be entirely separate and should require the other to have preceded it. There was also abundant illustration for a course upon the art of mining in the great number of mining models which had during several years been brought together within the walls of the museum.

2315. Does the collection at Jermyn Street differ from any to be found in other institutions?—Up to the time of the opening of the museum in Jermyn Street there was no public institution which represented the mineral wealth of Great Britain, and it has been, in what regards mineral specimens and models, as far as possible, kept within the limits of exhibiting and illustrating in every way, for enlarging, if possible, the mineral wealth of this country. The aim and scope of the collection is thus special and different from any other.

2316. Is the Jermyn Street establishment frequently visited by foreign technical visitors?—We have had visits from a very great number of them.

2317. What opinions have they expressed?—When in London I generally meet with those who come from Prussia, Belgium, and France more especially, and I have had most satisfactory opinions given me with regard to them by men of the very highest position in that respect. I may instance such a man as Von Cotta, the professor of geology at the mining school at Freiberg, in Saxony, who is the chief author in modern times of works on mineral veins and the application of mineralogy and geology to mining; and another authority whom I would quote is Signor Sella, the present finance minister of Italy; and several Americans, also, who have taken up those specialities, such as Professor Rockwell, Professor Brush, and others, have spoken in the highest terms of the nature and completeness of our collection.

2318. Are you often asked for advice on minerals and mining questions by mining agents?—A good deal of one's time in Jermyn Street is occupied in that way by men of all classes, who come to obtain gratuitous advice with reference to either specimens of minerals or some matters of mining, and especially with regard to the recommendation of agents, sometimes for agents of experience for the purpose of inspecting properties, and in other cases for young men to go out to take charge of different works.

2319. To be employed at home?—To be employed some at home, and some in the colonies.

2320. Do you think that the school has been advantageous in that way?—It is hardly perhaps for me to give an opinion on such a subject, but I think that in the country at large amongst men connected with mines a favourable opinion has generally been passed.

2321. Are you often able to give them advice in the shape in which they ask for it?—Very frequently.

2322. Have objections been made to London as the proper seat for a mining school?—Objections have been made by a great many of our practical men, and I confess that I have felt it myself sometimes. It was a doubtful question whether a mining school would attain a proper practical character if it were situated at the distance that London is from the mining districts; but, on the other hand, there is so much difficulty in fixing upon any centre of mines as a satisfactory seat for a mining school that up to the present moment opinions by no means coincide. Men in the neighbourhood of Newcastle naturally

think that Newcastle is the best centre, whilst in Cornwall they are equally of opinion that it should be at Truro or at Redruth; and London has certainly very great advantages for a central school, in the shape more especially of the better class of high scientific instruction which can be expected at head-quarters.

2323. Is it not the case, that even if the school were not already established in London, the choice would probably be between having a central school in London or several schools in the country?—I think it would undoubtedly.

2324. Are you acquainted with schools of the same kind on the continent?—I have visited most of them, and at some of them I attended courses of lectures as at Freiberg and Schemnitz, many years ago, and I have visited some of them even during the last year.

2325. Is their organization in general different from that of the School of Mines?—As a general rule the curriculum is more extensive. The pupils are required very frequently to pass a longer time than we expect our students to do here, in some instances as much as four years being required in a great measure for the purpose of educating young men to be government officers in connexion with the department of mines. I have here a statement which I have drawn up, showing the newest arrangements in the matter of mining schools in Prussia, a country which, with a total number of mining population probably about one half of our own, has no less than 20 mining schools scattered over the country. Two of them are termed mining academies—one, the chief academy at Berlin, which, besides five professors appointed specially for it, takes advantage of the lectures given by Professors Rose, Beyrich, Rammelsberg, and other professors of the university. The Mining Academy at Berlin numbers, as I learn from one of the professors, 70 to 80 students. The Trades Academy [*Gewerbe*], mostly attended by mechanics, has 600 to 700; the Building [*Bau*] Academy 300 to 500 students. Then there is a second mining academy at Clausthal in the Harz, which used to be Hanoverian. There is also at the same place a mining school or Bergschule, in distinction to the Bergakademien. There is another at Tarnowitz and one at Waldenburg, one at Eisleben, one at Bochum in Westphalia, and one at Siegen, in the district of Bonn, one at Saarbrücken, one at Dillenburg, and one at Bardenberg. So that there is a total of two mining academies, nine mining schools, and nine preparatory schools. The following paper will place this more clearly before the Commissioners:—

#### SCHOOLS OF MINES IN PRUSSIA, 1870.

Under his Excellency the Minister for Trade, Commerce, and Public Works, Count von Itzenplitz, &c. &c. Handelsministerium.

##### 1. Mining Academy at Berlin [Bergakademie].

Director Hauchecorne — Berggrath and Bergassessor, teaches *Bergbaukunde*, art of Mining.

Lecturers—Prof. Kerl, Metallurgy and Chemical Technology.

Dr. Wedding, Iron Metallurgy.

Dr. Finkener, Mineral Analysis.

Prof. Hörmann, Mechanics and Machinery.

Mr. Kauth, Surveying and Dialling.

Lectures given besides by Rose, Beyrich, Rammelsberg, and other professors of the University.

##### 2. Mining School [Bergschule] at Tarnowitz.

3. Do. do. Waldenburg.

With preparatory schools at Waldenburg, Gottesberg, and Schlepel.

4. Mining School at Eisleben (1st class), with three preparatory schools.

##### 5. Mining Academy [Bergakademie] at Clausthal.

Director von Groddeck, with seven lecturers.

##### 6. Mining School at Clausthal.

7. Do. do. in Dortmund district at Bochum.

8. Do. do. at Siegen, district of Bonn.

9. Do. do. at Saarbrücken.

With preparatory schools at Völklingen, Duttweiler, Neunkirchen.

##### 10. Mining School at Dillenburg.

12. Do. do. for overmen at Bardenberg..

Total—2 mining academies.

9 mining schools.

9 preparatory schools.



I should mention that a discussion upon the same subject is I believe still going forward in Austria, where formerly, when I was a student in these matters, there was only one mining school at Schemnitz in Hungary, then visited by as many as 300 students at once; but owing to the political troubles of 1848 and 1849 it became desirable to establish mining schools in some of the German States, and one was placed at Leoben, in Styria; and a second mining school at Przibram, in Bohemia; but since that many of the mining authorities appear to consider it desirable to establish a central school at Vienna. This has been in great part based upon the success of the superior scientific lectures which have been given by Von Haidinger, and I believe that subject is still under discussion.

2326. In Prussia, where there are so many mining schools, do you know whether the mines belong to, or are worked by, the Government?—The mines are not to any great degree worked by the Government, but the minerals are taken under leases from the Government, and there is a large staff of Government officers required in consequence to make all the arrangements necessary for the working of the minerals.

2327. Are the young men who have been trained in those colleges entitled to any preference for appointments in the working of the mines?—A certain class of them, I think, in all the continental schools, for which probably the colleges originally were chiefly intended, are those who enter with the intention of passing through the whole course, and of getting those Government appointments, subject of course to proper conditions; but a great number of other young men enter as external pupils or occasional students.

2328. Do the greater part of those who are trained in the colleges find employment in the mines sub-

sequently?—A large proportion of them. Many, however, go through certain courses for the purpose of becoming afterwards smelters and chemical manufacturers.

2329. It is a good training, is it not, for other branches of professional employment?—An excellent training for technical occupations.

2330. Are those schools connected with Polytechnic schools?—They are mostly separate entirely, and intended to take students who have completed their course at the Polytechnic and other general schools.

2331. Is there a stiff preliminary examination on entering the mining colleges?—Moderately so in some cases, and in some cases it is severe.

2332. (*Mr. Samuelson.*) That refers, I presume, to the colleges, not to the mining schools?—To some of those which are called schools, schools of the first class.

2333. Have you any means of ascertaining what has become of the men who have passed the Jermyn street classes?—I have here a list of the whole of the students who have been examined by myself in the two subjects of mineralogy and mining, omitting therefrom a good many who have attended the lectures but have retired from the examination; and, although we have no official means of knowing what becomes of the students, I think that this list is extremely satisfactory, as showing, in the first place, how many of them have acquired a true taste for science, by the great number of pupils who carry the letters F.G.S. after their name, and that most of them have obtained satisfactory employment, either in connexion with actual mines in our own country, with the Geological Survey in our country, and in some cases in the colonies, and with a number of private works of various kinds, which list I will beg leave to hand in.

W. W. Smyth  
Esq., F.R.S.  
5 July 1870.

LIST OF STUDENTS examined in MINERALOGY and in MINING.

Name.	Class in		
	Mineralogy.	Mining.	
Blanford, H. F.	I. 1852	II. 1853	Geological Survey of India. F.G.S.
Blanford, Wm.	I. 1853	I. 1854	Geologist to Abyssinian Expedition. F.G.S.
Hunt, R.	I. 1852	III. 1853	Mint, Sydney. F.G.S.
Bauerman, H.	I. 1852	II. 1853	F.G.S., late Geologist to Boundary Commission.
Jervis, W. Paget	I. 1852	III. 1853	F.G.S., Real Museo Industriale, Turin.
Minton, S.	II. 1852	III. 1853	F.G.S., Lessee and worker of collieries, S. Staffordshire.
Burbidge (Hambly)	— 1852	— 1853	F.G.S., Manager, Mount Sorrel Granite Works.
Hodgson	— 1852	— 1854	
Morgan	— 1854	— 1854	Engaged in colliery work, South Wales.
Baker	II. 1853	III. 1854	Manager of white lead works, Sheffield.
Smith	II. 1853	—	In the United States.
Fowler	—	— 1854	
Wright, C. Tylden	—	III. 1854	Manager of the Shire-oaks Collieries, Notts.
Carey	II. 1854	—	
Kennedy, Myles	—	III. 1854	F.G.S., Owner and manager of iron mines, Ulverstone.
Roper, R.	II. 1853	II. 1854	F.G.S., Ironmaster, Cwm-brae, S. Wales.
Hakki, Effendi	III. 1854	—	Major in Turkish army.
Wilson	II. 1854	—	
Leech	I. 1855	III. 1855	Teacher of Chemistry, Staffordshire.
Ronaldson	II. 1854	—	
Wilkin	I. 1855	II. 1855	
Wall, G. P.	I. 1854	I. 1855	F.G.S., Author of Geological Report on Trinidad, &c.
Darlington	III. 1854	II. 1855	Zinc smelting works, Ruabon.
Drew, Fr.	I. 1854	I. 1855	F.G.S., Mineral Surveyor to Maharajah of Kashmir.
Davis	— 1854	—	Iron works near Ulverstone.
Baker	II. 1855	III. 1854	Was on Mineral Surveys in N. America.
Dolby	II. 1855	—	
Wavell	II. 1854	—	Was at Staff College.
Mahmoud, Effendi	II. 1855	III. 1856	Died at Constantinople.
Jones	— 1855	— 1856	
Hoffman	— 1855	—	
Lloyd	— 1855	—	
Gould, Chas.	I. 1855	II. 1856	F.G.S., Director of Survey, Tasmania.
Tween	I. 1856	III. 1856	Curator of Geological Museum, Calcutta.
Monteiro	I. 1855	II. 1856	Manager of Mines in West Africa.
Bell, A. M.	II. 1855	II. 1856	
Child, H.	I. 1856	II. 1856	Died on Geological Survey of India.
Sheriff	I. 1855	II. 1855	Was occupied with coal-cutting machines.
Fowler	II. 1856	II. 1856	
Ordonez	—	— 1856	Mines of New Granada.
Pearson	—	—	
O'Donoghue	—	— 1856	
Morland	I. 1856	—	



W. W. Smyth,  
Esq., F.R.S.  
5 July 1870.

Name.	Class in		
	Mineralogy.	Mining.	
Thornton - - - - -	II. 1856	II. 1857	Accompanied Dr. Livingstone. Died in Africa.
Hopkins - - - - -	II. 1856	—	
Bullen, Mark - - - - -	II. 1856	— 1857	Engaged in mining near Middlesboro'.
Matthey - - - - -	II. 1856	—	Assayer, Hatton Garden.
Freeman - - - - -	—	— 1857-8	
Evans - - - - -	III. 1857	II. 1857	
Stephens - - - - -	— 1857	— 1857	
Weston, W. - - - - -	II. 1857	I. 1858	F.G.S., Chemist to Admiralty, Portsmouth.
Stubbs - - - - -	III. 1857	II. 1858	Died.
Wilson - - - - -	III. 1858	— 1858	
Foot - - - - -	II. 1858	—	Geological Survey, India.
Pilkington - - - - -	II. 1858	—	Chemical Works, Great St. Helens.
Stephens, T. R. - - - - -	III. 1858	—	
Featherstonehaugh - - - - -	— 1852	III. 1853	
Simes - - - - -	— 1852	—	
Foster, C. Le Neve - - - - -	I. 1859	I. 1859	F.G.S., Reduction officer, Pestarena Mines.
Fedden - - - - -	II. 1858	I. 1859	F.G.S., Geological Survey of India.
Wood, C. S. - - - - -	I. 1858	I. 1859	Teacher at Bristol. Died in New Zealand.
Birkenhead - - - - -	II. 1858	I. 1859	Teacher at Wigan. Died.
Heath - - - - -	II. 1859	II. 1861	
Meredith, Alban - - - - -	II. 1859	III. 1859	Late Manager of Ironworks, Askam, and Steelworks, Sheffield.
Danby, T. W. - - - - -	I. 1859	I. 1860	F.G.S., Natural Science Tutor, Trinity College, Cambridge.
Mills - - - - -	II. 1860	—	
Punnett - - - - -	II. 1860	II. 1860	Agent to Messrs. Williams & Co., Copper Smelters.
Wynne - - - - -	—	I. 1860	Colliery Viewer, North Staffordshire.
Nicholson - - - - -	—	I. 1860	Collieries near Newcastle.
Wyman - - - - -	I. 1861	II. 1860	Mining business in S. America.
Twite - - - - -	—	II. 1860	Late Government Mining Agent in Paraguay
Barratt - - - - -	—	— 1860	Hodbarrow Iron Mines. Died.
Jenkins - - - - -	I. 1860	I. 1860	F.G.S., Secretary Royal Agricultural Society
Child, W. - - - - -	I. 1860	I. 1861	Late Chemist to Dowlais Iron Works.
Hackney - - - - -	I. 1860	I. 1861	Engaged in applying Mr. Siemen's regenerative furnaces to the steel making.
Dunn - - - - -	II. 1860	II. 1861	
Davidson - - - - -	II. 1860	—	Instructor in Chemistry, Naval School.
Topley, W. - - - - -	II. 1860	III. 1861	F.G.S., Geological Survey.
Moore, W. H. - - - - -	III. 1860	II. 1861	Staffordshire Fire-brick works.
Stiffe, Lieut. - - - - -	—	I. 1861	On service in East Indies.
Bishopp - - - - -	I. 1861	I. 1862	Died.
Peach - - - - -	II. 1861	—	Geological Survey.
Wilkinson - - - - -	I. 1861	I. 1862	Died, on Geological Survey of India.
Hughes - - - - -	I. 1861	II. 1862	Geological Survey of India.
Atkinson, George - - - - -	II. 1861	—	Colliery Viewer, Forest of Dean.
Lumby - - - - -	II. 1861	II. 1862	
Watson - - - - -	— 1861	—	
Taylor, R. - - - - -	III. 1864	—	Managing Mines, Gonnese, Sardinia.
Jordan - - - - -	II. 1861	—	
Tawney - - - - -	I. 1862	I. 1863	F.G.S., author of papers on Rhætic formation.
Knobel - - - - -	I. 1862	—	Chemist, Burton Brewery.
Gilfillan, G. F. - - - - -	II. 1862	III. 1863	Mineral Exploring Company, Cape of Good Hope.
Wilson, G. - - - - -	II. 1863	—	
Gordon, Davis - - - - -	II. 1863	I. 1864	Agent for English Mining Company, Sardinia. Died.
Judd, J. W. - - - - -	I. 1863	—	F.G.S., Geological Survey.
Potter, F. W. - - - - -	I. 1863	—	Mining Agent, near Wirksworth, Derbyshire.
Baker, H. W. - - - - -	I. 1863	II. 1864	Died.
Gibb, Thomas - - - - -	I. 1863	I. 1864	Manager, Copper Extraction Company, Newcastle.
Bell, J. C. - - - - -	I. 1863	—	Chemist, Spence's Works, Manchester.
Levick, T. - - - - -	III. 1863	I. 1863	Late of Blairston Iron Works.
Levick, G. - - - - -	III. 1863	III. 1863	
Willis - - - - -	III. 1863	—	Chemist to Landore Steel Works.
Finch, F. G. - - - - -	I. 1863	II. 1864	D. Sc. F.G.S., Blairston Ironworks.
Macmurdo - - - - -	III. 1864	—	
Holmes - - - - -	III. 1863	—	
Brown, H. - - - - -	II. 1863	—	
Brown, C. B. - - - - -	II. 1863	—	Geological Survey of Demerara.
Roberts, W. C. - - - - -	I. 1863	II. 1864	F.G.S., Chemist to Mint.
Ward, J. C. - - - - -	I. 1863	—	Geological Survey of England.
Robinson - - - - -	II. 1864	III. 1866	
Maybury - - - - -	I. 1864	—	B. Sc.
Geogan - - - - -	II. 1864	—	
Molteni - - - - -	I. 1864	I. 1865	
Potter, F. A. - - - - -	III. 1864	II. 1865	
Parkinson - - - - -	II. 1865	—	
Mouatt - - - - -	II. 1864	II. 1865	
Etheridge, R., jun. - - - - -	II. 1864	—	F.G.S., Geological Survey of Victoria.
Scrymgeour - - - - -	— 1864	—	
O'Sullivan - - - - -	I. 1864	—	
Taylor, H. C. - - - - -	III. 1864	III. 1866	
Rowden - - - - -	I. 1865	I. 1866	Teacher, Bristol mining school, and since at Newcastle.
Poole, H. - - - - -	— 1865	II. 1867	Pictou coal mines, Nova Scotia.
Benn - - - - -	— 1865	III. 1865	
Rutley - - - - -	II. 1865	—	Geological Survey.
Griffith, Nathl. R. - - - - -	II. 1865	I. 1866	Manager of Coppa Collieries, Flintshire.
Craik - - - - -	II. 1865	—	
Piesse - - - - -	— 1865	—	
Taylor - - - - -	I. 1865	II. 1865	
Salter - - - - -	II. 1865	—	



Name.	Class in		
	Mineralogy.	Mining.	
Berrell - - - -	II. 1865	—	Science teacher. Died.
Holdich - - - -	III. 1865	—	Assayer, Morfa Silver Works, Swansea.
Maurice - - - -	III. 1865	II. 1866	
Davis - - - -	III. 1866	—	
Snelus - - - -	I. 1866	II. 1867	Chemist to Dowlais Iron Works.
Richards, W. F. -	— 1866	—	
Whichelo - - -	III. 1866	—	Chemist, Bass's Brewery.
Thorp - - - -	— 1866	—	
Richards, E. - -	I. 1866	II. 1867	
Willans - - - -	III. 1866	—	
Bell, W. E. - - -	III. 1867	—	Chemist, Landore Works, Swansea.
Black, H. A. - -	I. 1867	—	Obtained a scholarship at Oxford, and left.
Cloud, T. - - -	II. 1867	—	Assayer, Wallaroo Copper Co., Australia.
Browne, L. - - -	II. 1867	—	Chemist to Iron Works, Nottingham.
Thorpe, Wm. - -	III. 1867	—	Chemist to Rivers Commission.
Fox-Strangways -	I. 1867	—	Geological Survey.
Richards, W. F. -	II. 1867	—	Chemist, Barrow Ironworks.
Jones, Thos. - -	II. 1867	—	Science Teacher.
Griffiths, J. A. -	III. 1867	II. 1868	
Collins - - - -	II. 1867	—	Teacher to Miners' Association of Cornwall.
Buckley, F. - - -	—	— 1867	
Broome, Gordon -	I. 1868	I. 1869	F.G.S., Lecturer, Helmoth College, Canada.
Butler, F. H. - -	I. 1868	III. 1869	Exhibition, Oxford.
Douglas, G. R. -	III. 1868	—	
Elliott, M. - - -	II. 1868	—	
Frechville - - -	II. 1868	—	Managing Westminster Gold Mine, Nova Scotia.
Green, G. - - -	I. 1868	—	Copper Extraction Company, Newcastle.
Martin, Elias - -	III. 1868	—	
Maury - - - -	II. 1868	I. 1869	Min. Agent, State Land Office in Virginia, U.S.
Page, F. J. - - -	II. 1868	II. 1869	
Tanner, H. W. L. -	II. 1868	—	Exhibition, Oxford.
Williams - - - -	III. 1868	—	
Robinson, R. Bird	—	II. 1868	Hæmatite Works, Cumberland.
Foster, E. Le Neve	I. 1868	II. 1868	Assist. Reduction Officer, Pestarena Mines.
Liversidge - - -	I. 1869	I. 1870	Exhibition, Cambridge.
Johnson, Sollas -	I. 1869	—	" "
Wright, P. - - -	III. 1869	—	
Noble - - - -	— 1869	—	
Gowland - - - -	I. 1869	I. 1870	Copper Works, Manchester.
Bickerton - - -	III. 1869	— 1870	Science Teacher, Hartley Institute, Southampton.
Bayley, F. W. - -	III. 1869	II. 1870	
Renwick - - - -	II. 1869	I. 1870	
Jewesbury - - -	II. 1869	—	
Dillon, E. - - -	I. 1869	II. 1870	
Wilkinson, Thos. -	— 1869	II. 1869	Agent at Silverdale Collieries, Staffordshire.
Terry - - - -	III. 1869	I. 1869	Mine Agent, Dudley.
Tait - - - -	— 1869	— 1870	
Shuttleworth, R. K.	—	— 1869	
Williams, Ch. - -	—	II. 1869	
Atkinson - - - -	I. 1870	—	
Ballard - - - -	II. 1870	—	
Bowrey - - - -	II. 1870	—	
Chapman - - - -	— 1870	—	Chemist to Government, Jamaica.
Downar - - - -	III. 1870	—	
Gilchrist - - - -	I. 1870	—	
Herman, W. D. - -	II. 1870	—	
Jackson, M. - - -	II. 1870	—	
Mallet, F. R. - -	I. 1870	—	
Miller, Hugh - -	III. 1870	—	On leave from Geological Survey of India.
Parker, T. Jeffery	II. 1870	—	
Taylor, Frank - -	I. 1870	—	

W. W. Smyth,  
Esq., F.R.S.  
5 July 1870.

2334. (*Chairman.*) Are many of them employed as managers of mines?—Not a great number.

2335. Do you think that there are reasons why that is not to be expected?—There are reasons of different kinds in different mining districts. In the metalliferous mine districts, say of West Wales, Cornwall, and the Isle of Man, &c., it is desirable usually to select for the management of the mines men who have been raised from the ranks, who are thoroughly good workmen, who evince the power of commanding other men, and who shall have a thorough knowledge and experience of what is technically called breaking ground; and the reason for this is, that so large a proportion of the total expenses of a mine consists in the charge of breaking ground by blasting or otherwise, that unless a man is a good judge of that the mine is not likely to succeed; and the greater chance of commercial success is ascribed to a man for his being a good judge of this than for his being a man of scientific attainments. In the colliery districts, on the other hand, there is frequently another reason, and that is, as in civil engineering so in colliery engineering

or colliery viewing, as it is commonly called, it is usual for an engineer of repute to take a number of pupils into his office. Those pupils pay down a handsome sum for the privilege of attending in his office and being admitted to the practice of the collieries with which he is concerned, and necessarily they look with a little jealousy upon any system by which young men should be prepared for such a position without having passed an apprenticeship in their offices.

2336. The young men who have passed through the courses of the School of Mines have, as a general rule, to learn the practical part of their business subsequently, have they not?—The greater part of them. A few have come there after acquiring some practice, and those have generally distinguished themselves by taking good classes.

2337. They have acquired a certain amount of practical knowledge, and they then come to you for the scientific knowledge?—Yes, and I only wish that more of them could come prepared in that manner.

2338. Do you think that means could be adopted for increasing the number of such students?—I think



W. W. Smyth,  
Esq., F.R.S.

5 July 1870.

it is very probable that as the advantages of the school become better known a larger number will come forward.

2339. Do you see any tendency to increase in the number of practical men coming to you as students?—Within the last few years we have had a larger attendance, but the increase has not been very marked.

2340. Do you think that the lecturer himself derives advantage from intercourse with engineers and managers of mines, and other persons connected with mines?—I think it is one very important matter indeed that with regard to a technical subject of that kind, the lecturer and his students should be brought in contact with them as much as possible. I hold, therefore, that besides our connexion with the Geological Survey and the Mining Record Office, my own position, as dealing practically with the mines of the Prince of Wales and those under the Woods and Forests, is of very great value to the students, inasmuch as I have daily necessity for becoming acquainted with all the conditions under which mines are let as well as worked, and that gives me an opportunity of either taking with me some of the students occasionally to see the working of the mines, or giving them suitable hints and introductions.

2341. Do I understand that you take your students down to Cornwall occasionally?—I have occasionally taken several, but it is very commonly the case that one or two accompany me, and in other cases I give letters to my assistant in Cornwall, or to some of the managers of the mines with whom I am connected.

2342. (Sir John Lubbock.) You are very intimately acquainted, are you not, with the mining industry of Cornwall?—Yes, very intimately indeed with Cornwall.

2343. The mining districts of that county have been long of great magnitude and importance?—Very long indeed, and of very great importance.

2344. Do you consider that acquaintance with the science of mining enables much economy to be effected in the selection and working of a mine?—I think it is extremely important, and to a greater extent than our shareholders are generally aware of.

2345. Has not the production of copper ore in South America in the last few years very materially interfered with the prosperity of the Cornish mines?—It has interfered very much with copper mining, but, on the other hand, the tin ore has recovered from its depression of a few years since, and that has tended in some measure to make up for the depression in copper. Mining is very active at present in Cornwall.

2346. The two industries are to a certain extent separate, or independent one of another, and I believe copper is now in a state of great depression, is it not?—It is so.

2347. A good many copper mines are closed, are they not?—Many of them have been closed.

2348. And that throws a great number of hands out of work?—Yes, a great number.

2349. I suppose you think that a great deal of the difficulty which occurs in consequence of the working of the Cornish mines might become balanced by more scientific methods of working them as compared with those in distant countries?—Undoubtedly. There are also two or three difficulties which have arisen of late years, and which may to a great extent probably be overcome in the future by extended knowledge. One of them is the very large proportion of poor ores which we get in Cornwall, that is to say, ore of very low per-centage, and in which certain noxious ingredients are largely present, such as iron pyrites and arsenical pyrites, about which it is very probable indeed that further metallurgical and mechanical knowledge may produce a great change in the results of working such mines.

2350. I gather that it is peculiarly important, under present circumstances, with reference to the interests of Cornwall, that a diffusion of scientific knowledge should be secured as generally and as rapidly as pos-

sible?—I believe it is beginning to be strongly felt in Cornwall itself.

2351. In fact it is almost necessary at the present time?—Yes, it is so.

2352. (Mr. Samuelson.) You have stated that there is a difficulty in teaching a subject so technical as that of mining in the ordinary way. Do you consider that by any system of examination by papers from a centre like that of South Kensington the qualifications of pupils can be sufficiently ascertained?—It is not altogether satisfactory.

2353. So that in that respect the subject of mining stands on a somewhat different footing from the other numerous subjects which form part of the South Kensington programme?—I think it does. It is like other technical subjects; take, for instance, tailoring. A man might give you a very good account on paper how a coat should be cut, and how the different seams should be sewed together, and yet perhaps he might not be able to make a stitch himself. In the same way a mining man may write very plausibly, but he may be very unfit to receive honours in mining.

2354. Do you think that that is peculiar to mining, or does not it apply also to other technical subjects?—It must apply more or less to all the technical subjects where a handicraft comes in, and where actual experience is needed.

2355. Can you suggest any plan by which the qualifications of those students could be ascertained more thoroughly than by a system of papers like that of South Kensington?—I think that great care on the part of examiners may to some extent counteract the difficulty. I see for instance in many a paper very distinctly whether a man writes from a practical acquaintance with what he is describing as a general rule, but I am scarcely prepared to devise a scheme for actually ascertaining a man's practical fitness.

2356. Seeing that the number of mining districts is comparatively small, and may be defined, do you think it may be possible to conduct local *viva voce* examinations in certain centres?—Not I think without a very great amount of expence. Seeing the very outlying position of many of the mining districts, I think it would be coupled with great difficulty.

2357. You mean expence in bringing the pupils up for examination, I presume?—Either in bringing the pupils up for examination, or carrying the examiner to the neighbourhood of the pupils.

2358. The extreme points, I suppose, would be Cornwall and the coalfield of Lanarkshire?—It is not so much the actual distance which constitutes the difficulty. The difficulty, as it appears to me, is, that if you were to take a district like Wales, you may get a number of valleys ramifying in different directions with mines seated in them, and very few people dwelling in each valley, and yet requiring schooling of this kind, and, consequently, great difficulty in getting a satisfactory system of schooling, not to say of examination.

2359. That would apply more, would it not, to teaching than to examination?—It does so.

2360. That is one difficulty that local mining schools really have to contend with?—Undoubtedly.

2361. I believe that great efforts have been made in Cornwall by a small number of persons to spread instruction in the sciences relating to mining?—There have. I have been a subscriber to that school from the first, and I have seen something of its working, and I think that the amount of good that has been done by it is very creditable to the few and rather moderately paid teachers who have been employed.

2362. Have the owners of the large mines contributed satisfactorily to the funds for the support of those schools?—Not very generally. Many of the Cornish mineral owners have subscribed; but, as a general rule, the great misfortune is the fact of the shareholders being often parties residing at a distance from the mines, which has militated against assistance being obtained from the body of the shareholders.

2363. And also, I suppose, it is owing to the fact of their being a fluctuating body?—Yes.



2364. In the great smelting district of Swansea, for instance, is there anything in the nature of a local mining or metallurgical school?—I am not aware that there is. From that district some young men have come within my knowledge to the Bristol mining school, and a school has been talked of at Swansea, but I am not aware that it has been actually established.

2365. The Bristol school suspended its operation some time since, did it not?—I think it did.

2366. Is it now again in full activity?—I have not heard of its working lately. Mr. Brough, who, I believe, is called, will be able to give the Commission information upon that point.

2367. With regard to the smelting works in South Wales, and speaking more especially now of copper and zinc, is it the case that the owners of those works have procured managers and other responsible servants from the continent?—Yes, that has been repeatedly the case.

2368. How do you account for that?—Because they could not get men who have passed through the same courses in England. Mr. Vivian, as long as 25 years ago, was obliged to get assistants who had passed the courses at Freiberg.

2369. I do not ask the question in disparagement of the mining school in Jermyn Street, but how do you account for your own people taught in that school not having obtained those appointments rather than foreigners?—I think that a reference to that list which I have handed in will show that a great many have obtained those appointments of late in South Wales. Therefore that is no longer the case to the same extent, for we are now supplying managers who have been students at the mining school.

2370. Could you give an instance of that?—I may mention that one of our students who took first classes with us in the years 1860 and 1861 is now engaged in applying under Mr. Siemens the regenerative furnaces to steel making at Landore and elsewhere.

2371. Mr. Siemens himself being a foreigner and well acquainted with all the continental schools?—Yes.

2372. To some extent I suppose the mining school in Jermyn Street was under the usual disadvantage of a new institution?—Quite so. There are many parts of the country in which they have scarcely heard of it.

2373. And on having heard of it, it would naturally take some time before it commanded the full confidence that has been enjoyed by the old continental schools?—As a general rule I think it may be said that a school of that kind requires to get into full swing something like two or three generations.

2374. Are you acquainted with the mining school at Wigan?—Not intimately. I recollect the master, Mr. Birkenhead, attending my classes.

2375. That school has ceased to exist, has it not?—I was not aware of that. I may state that I have received in the last examination several papers, which bear internal evidence of coming from the neighbourhood of Wigan, so that I presume that they must have been sent by classes which have started independently of the school.

2376. You have stated that the amount of schooling for the various classes of workmen and assistants should be very different; would you not say that the schools should correspond to the requirements of those various classes in grade?—Yes.

2377. That I believe is the case in the continental schools?—It is so. There are schools especially for overmen in France, and I may instance that very capital men have been turned out from the school at Alais who are intended for first-class artisans.

2378. The school at Alais being intended for foremen, and the École des Mines in Paris for mining engineers?—Quite so.

2379. The same arrangement prevails in Germany also?—Yes, in the Prussian schools also.

2380. Are you acquainted with the school at Bochum?—I have never seen it.

2381. Are you personally acquainted with any of the Prussian mining schools of the second grade?—I have talked with people connected with those at Siegen and Clausthal, but I do not know their working intimately.

2382. Are you aware that those secondary schools are in nearly every instance supported in a great measure by local contributions?—No, I was not aware of that.

2383. But is it your opinion that the state can be expected to provide all the funds required for the establishment of such schools in this country?—No, I see no reason at all why they should not be largely supported by voluntary contributions.

2384. Is not the direct interest of the mine-owners so great that they may be fairly expected to contribute?—Unfortunately a great many of them do not see it to be their interest, and so it generally falls very heavily upon the few.

2385. Is not that state of things beginning to change somewhat?—I think it is, from the active part that has been taken recently by the committee of the Institute of Mining Engineers in the north of England.

2386. Are you aware that until within the last two or three years the leading persons connected with mining in the north of England were quite unaware of the assistance which South Kensington was giving to schools of this kind?—Yes, I am aware of that.

2387. And it was after Mr. Daglish had been summoned as a witness before a committee of the House of Commons the first effort was made to establish science classes in the colliery districts of the north of England?—I was not aware before that he had attended that committee.

2388. Do you know whether there is any mining school in North or South Staffordshire?—I am not aware that there is; I think there is not.

2389. Do you think that there is any mining or metallurgical district of equal extent in any part of continental Europe to that of North and South Staffordshire without a mining school?—No, certainly not.

2390. Are you aware that the value of the minerals of every kind in that district is increasing daily, owing to their increasing scarcity?—I presume that it is so locally.

2391. Under those circumstances would you not think that economy of working would be necessary for the prosperity of the district?—There can be no doubt whatever, especially to those who have seen the great waste that has been carried on in the working of the thick coal there.

2392. With reference to the smelting of copper and zinc, is it not the case that many of the more valuable processes for utilising lean ores have originated on the continent?—I believe that they have.

2393. And that many of them are of a highly scientific nature?—Yes. I should mention that I have recently heard that one of those processes has been so successfully adopted by one of our late students, that he is making a very large income from a process, to some extent devised by him, for the treatment of some of the refuse copper ores.

2394. That process, I suppose, is one depending upon theoretical considerations?—Undoubtedly.

2395. You say that some of the papers received show much practical acquaintance with one district, but great want of knowledge of what is done in others. Would not a more thorough scientific teaching be a great corrective of such a state of things?—Undoubtedly, it would. Greater intercommunication between different districts is very much wanted. That has been to some extent supplied in the colliery districts of late years by the reports of the coal mine inspectors under the Home Office, and by the action of the institutes of mining engineers in different districts; but the communication is still defective.

2396. And that state of things exists, notwithstanding the greater rapidity of communication of late years throughout the country?—If does, in some dis-

W. W. Smyth,  
Esq., F.R.S.  
5 July 1870.



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tricts, very naturally, on account of the inaccessibility, comparatively speaking, of mining localities.

2397. But taking, for instance, the subject of coal mining, and the districts of Staffordshire and the north of England, is it not the case that the diversity of practice in those two districts can scarcely be accounted for, entirely upon the consideration merely of the different circumstances of those districts?—It is most difficult to understand.

2398. In point of fact, in some districts the rule-of-thumb prevails in spite of everything?—It is quite so.

2399. Do you think that that state of things has a prejudicial bearing upon the safety of mines?—Yes, to a very great extent. In nothing is it more remarkable than in the prevalence throughout the greater part of the country of a system of making plans upon the magnetic meridian, instead of the true meridian, and the total ignorance on the part of many people who survey mines of that magnetic meridian being liable to change; so that you may have occasionally a working supposed to be safe, and which may be directing the men straight to their destruction.

2400. Are you acquainted at all with the degree of education of managers and of practical miners on the continent?—Yes, I have seen a good deal of them.

2401. Taking the two classes separately, how would you compare the state of instruction of each, say in France and in Germany, with the corresponding classes in England?—As a general rule the managers with us are very inferior in general acquirements, but they often make up for it by a greater amount of energy and practical acquaintance with their subject, whilst as a rule our workmen are far superior in practical knowledge and skill.

2402. Is there any reason to believe that the energy of our managers would be diminished if they were better instructed?—No; I think not. I may instance one case which occurred to me last week only. The chief officer of the very extensive Prussian mines of Mansfeld and Eisleben, M. Leuschner, was over here, and I gave him some letters of introduction to different parts of the country; he could scarcely speak a word of English, so that he was obliged to be dependent upon an interpreter to some extent, but he stated on returning, after visiting several of our works, that he had not seen much in the way of machinery that had surprised him, nor was he much struck with the knowledge of our managers, but he had been perfectly amazed at the skill and ability and energy and strength of the workmen with whom he came into contact.

2403. Then you would say that, taking economical considerations solely into account, we should aim chiefly at the education of our managers?—That is very strongly my impression.

2404. Do you think that that is likely to be accomplished by a central school, like the Jermyn Street school, to the extent to which it ought to be?—It can only be an extremely slow process.

2405. But, assuming that a somewhat advanced secondary instruction were within the reach of managers in their respective localities, do you think that their progress would be very much more rapid?—I think there is no question of it, and one great advantage which would be obtained by it would be the giving of them a greater interest in scientific subjects, bearing upon their profession, than in knowing what are the odds on some favourite horse.

2406. You think that the superior class of workmen, those from whom our overmen are now drawn, would avail themselves of such institutions if they existed?—I think where it is possible they would, generally speaking, be very willing to do so.

2407. The experience of the Cornish mining school, I presume, is confirmatory of that?—Quite so. One difficulty I ought to mention, which is, that as long as those better educated young men remain rare cases, it is very difficult to get them to go on with their handiwork, as there are so many inducements for them to go off into some side branch, to become clerks or something of that kind, whence there is a little feeling

against it on the part of the managers, and I believe until education becomes more general in the elementary schools, one can hardly expect to get over that difficulty.

2408. And that would be corrected, would it not, by the existence of such schools as we have been talking of?—Unquestionably.

2409. (*Dr. Sharpey.*) You are in favour of a more general diffusion of knowledge, so as to make individual cases less remarkable?—Yes.

2410. (*Mr. Samuelson.*) You would endeavour to combine practical work with theoretical instruction?—If possible, I should.

2411. Are you aware that that is done in the secondary mining schools in Prussia?—Yes, I am aware of that, and it has been very satisfactorily done by such classes in Cornwall.

2412. Those classes being evening classes?—Yes.

2413. No attempt, then, has been made to establish day classes in Cornwall, in which the pupils, being practical miners, pass a part of their year?—I can hardly undertake to say that no attempts have been made in that way, but the generality of the schools are evening schools.

2414. And the men have been working on the same day practically as that on which they have been studying?—Yes.

2415. As a rule, can the miners in Cornwall read and write?—No; the proportion of miners is perhaps rather large who cannot read and write, but amongst the children of the newer generation, those who are now growing up, the proportion of those who cannot read and write is probably about one-sixth.

2416. Do you anticipate that increased elementary education would indispose the boys to work with their hands in the mines?—It would undoubtedly if it were protracted too long; that is to say, if they were kept to an age of more than 11 or 12 at schools it would undoubtedly destroy them as workmen.

2417. Would you put the age so low as 12; or would you be inclined to extend it to 13?—No, certainly. I speak without the slightest hesitation, that children require so much to practise their eyes in observation in the kind of work which is put before them at the mines, that if their schooling were extended until they were 13, I believe that they would suffer materially as workmen.

2418. That being so, would you consider it possible to make night schools obligatory up to say 16 years of age as a condition of being allowed to work?—I think it would be very possible.

2419. You said that you frequently had applications to recommend agents, is that chiefly from mine owners or from persons engaged in the working of mines?—Principally from persons engaged in the working of mines, proposing to take or having an interest in colonial or other mines, generally speaking colonial.

2420. Comparing the higher mining schools abroad, those which you have called academies, with the School of Mines in Jermyn Street, are you able to draw any instruction from them as to improvements which might be made in your own institution?—Premising that in view of differences in the habits and business character of the people, our course of study as compared with the foreign, should be abbreviated, I think that we might be made more complete in one or two respects, by the introduction of a class on general surveying, and especially underground surveying, a subject needed very much by miners, and which at present our students would have to learn elsewhere. It is a speciality which can only be worked out practically, of course, in the mines.

2421. But the principles of which it would be desirable to learn in the school?—Yes.

2422. Is the entire absence of any instruction in mathematics a drawback to giving such theoretical courses?—There are so many other places where they can learn mathematics, that it is thought we might dispense with our teaching this among other preliminary subjects at the actual school, but hitherto the students have come with a very small amount of



preparation in mathematics, as might be expected from the small sprinkling of mathematics which is met with in a great portion of the schools in the country.

2423. In point of fact, during their attendance at your courses, have they acquired mathematical knowledge elsewhere?—I am not aware that they have, but a good many of them, who attended my courses, have a certain acquaintance with geometry, and algebra, although to a small extent.

2424. You have stated that there is some jealousy on the part of mining engineers to allow your courses to be substituted for an apprenticeship?—I have never heard any distinct expression of it, but it is very much the same as the feeling with regard to the general civil engineers which was exhibited at the time that the Civil Engineers' College was erected at Putney.

2425. Do you think that that jealousy was well founded?—To a certain extent. Yes, as regards the preparation for a particular district.

2426. But if an apprenticeship could be combined with theoretical courses, would not that on the whole perhaps be better than either of the other plans separately?—I believe that it would be a very important step, and some few of our students have adopted that plan; that is to say, they have come up from their apprenticeship with a colliery viewer, or in some cases have afterwards gone to a colliery viewer.

2427. They have first completed their apprenticeship, and then come to the mining school?—Or they have come away during a part of their apprenticeship. I am not quite certain whether others have taken their apprenticeship afterwards, as, for instance, did the manager of the extensive collieries of Shireoaks, in Nottinghamshire, the Duke of Newcastle's.

2428. If a school of mining were established in the centre of a mining district would there not be greater facilities for combining the two branches of instruction?—Certainly there would.

2429. And so far that would be an argument for the establishment of local schools in the great mining centres?—It is so, especially with reference to such a subject as I have just mentioned, underground surveying; they might learn that thoroughly in that way.

2430. Assuming large local colleges to be contemplated, do you think that there would be much difficulty in obtaining competent teachers?—At first I believe there would.

2431. That is to say, if you were to establish several colleges of that kind at the same time?—Quite so; it must be done by degrees.

2432. But if it were done at intervals of three or four years, you think that difficulty would disappear?—I believe it would.

2433. (*Dr. Sharpey.*) I think you said that your pupils would enter to your courses of instruction with more advantage if they had had some previous acquaintance practically with mining?—They would.

2434. Then of course I presume you expect that they should have previous instruction in general science, say in physics, chemistry, and mineralogy?—Yes.

2435. How do you think those two conditions could be combined; would you require them before they entered upon the study of mathematics and physics, and so on, to have had some practical acquaintance with mining, or supposing they first got their training in pure science, would you advise that they should go to a miner or a mining district and get some practical acquaintance with mining, and then take advantage of your special courses of instruction?—I think they might carry on some study of the practical part of the subject along with those elementary branches of science, and then that they should afterwards come up for the more applied portions. In fact, at the German colleges they frequently divide the course into an elementary or rather preliminary course, and then what is called a Fach-kurs or group of technical subjects.

2436. In a country like this they require, do they not, to have an opportunity of acquiring general scientific instruction in the locality where the mines are?—Yes, where it is possible.

2437. Do you think that if science teaching in our secondary schools were raised to the pitch which may be expected from the system likely to be introduced by the Endowed Schools' Commission, that amount of previous scientific training might be got in the locality? I see no reason why that should not apply to the greater part of the localities that you refer to.

2438. (*Professor Huxley.*) Supposing you were to take two men of equal abilities, and give one of them such theoretical training or such training in theoretical mining as you could give in Jermyn Street, and leave the other without it, and then train them both to become practical miners, which would be the better off?—There is no doubt about what would be the result, that the man prepared with a general knowledge of the subject would, as it were, gain a certain number of years over the other, and the man without that preparation would lose several years in acquiring an experience both of what he should do and what he should not do.

2439. Then technical instruction, even when unaccompanied by anything like real practice, is in your judgment a distinct advantage?—I believe it is.

2440. Supposing that the courses at the school of mines and mining, and so on, were confined to purely technical instruction, and that the requisite information in general science were attempted to be secured by preliminary examination, can you tell me what effect that would have?—It depends upon what subjects you would take as the element of your preliminary course.

2441. Supposing you took mathematics, physics, and chemistry?—I see no objection at all to their being considered preliminary, and I think to a certain extent that plan is adopted at Jermyn Street by consenting to take young men for the further stage who had passed examinations in those subjects elsewhere, or who can pass from the information which they have acquired elsewhere.

2442. Supposing no one were allowed to enter the School of Mines except such persons, what effect would that have upon the number of students there?—It might give a slight check at first.

2443. Do you think that before long the students would find means of acquiring the preliminary knowledge?—I believe they would.

2444. So that it would be no practical harm, you consider, if the courses in Jermyn Street were eventually limited to those which have a direct technical application?—No.

2445. And that eventually the supply of students might not be limited by that?—I believe so.

2446. (*Mr. Samuelson.*) Are you speaking now of the purely mining school, or would you include the College of Chemistry?—I am speaking of the purely mining school. Chemistry might be supposed to be a preliminary subject.

2447. (*Sir J. Kay-Shuttleworth.*) Looking to the importance of establishing subsidiary and preparatory schools in the several mining districts, and of not making those schools entirely dependent upon aid from the Government, have you considered whether or not it is probable that the requisite resources in the several mining districts of England could be provided by the voluntary contributions of the proprietors and of the persons who are lessees of mines?—I should think that in most cases, if a satisfactory scheme were put before them, a considerable portion of the expenses might be met in that way.

2448. If the scheme came with authority from some competent department of the Government, and sanctioned likewise by persons of great local experience, you think that that would stimulate local contributions?—I think so in most of the districts that I am familiar with.

2449. Have you considered whether it would be at

W. W. Smyth,  
Esq., F.R.S.

5 July 1870.



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5 July 1870.

all fair or proper if such a scheme were laid before a district, and such voluntary contributions were not made by the proprietors and lessees that, looking to the general interests of the country, their property should be liable to some assessment to be partly paid by the lessees and partly by the owners?—I should rather like to see that done.

2450. Have you any expectation that a mining school could be established in each centre of mining in England, subsidiary and preparatory to a central school, unless some such pressure were brought to bear upon the owners of property and the managers of mining industry?—I believe there are some districts where it is indispensable that some such screw should be applied.

2451. You particularly alluded to the fact, that in Cornwall, the shareholders are not only non-resident, and therefore have not a personal local interest in the miners, but are a fluctuating body, and really may be regarded as having merely a financial interest in this locality, would it not be just, speaking in the interests of mining industry, and looking to the general interests of the whole country, that such persons should be regarded as liable to assessment, if the persons locally interested assented to it?—I think that would be but fair, and for another reason also, which is, that in mines carried on by persons at a distance, one commonly finds the system of working itself to be somewhat different from that where the shareholders reside in the neighbourhood, in that they endeavour to extract from the mines in a short time everything that they possibly can, with too little regard to the future.

2452. You have spoken of the great waste that occurs in working the thick mines in Staffordshire, and I apprehend, that by the application of the highest scientific processes, a very considerable economy in the mining resources of Staffordshire might be obtained. In the interests, therefore, of that economy, is it not extremely important, that by means of subsidiary and preparatory schools, and the influence of a central school, more science should be brought to bear upon the mining industry of Staffordshire?—Certainly.

2453. And in fact, regarding it as a purely economical measure, it would be, like insurance, a wise expenditure to have an assessment of that property to ensure such a result?—I believe it would.

2454. In the same way, with respect to the obtaining of better economical results from a more scientific working of the poor copper ores of Cornwall, would it not be important that the shareholders should be subjected to the influence of the collective wisdom of the country, rather than be left to their own narrow view of their interests?—I think it is the only plan by which they could be made in many instances to contribute to a scheme of that sort, which must be advantageous to the general interests of the country.

2455. Generally speaking, I gather that you are of opinion that the establishment on all the grounds which have been brought out in the examination to-day, to which I will not recur, of preparatory and subsidiary mining schools in each district, is desirable, and that there is little hope of its being obtained unless the influence of the central government is brought to bear upon the districts?—Yes, that is the impression which I have formed from experience of the schools which have already been tried.

2456. (*Dr. Miller.*) Can you inform us as to what extent the Prussian schools of mining are endowed at the present time?—I am not aware. They are endowed by the State, but I do not know to what extent. The central school in Berlin, I believe, is endowed to a large extent, but as at ours in Jermyn Street, much economy in the payment of professors, &c., is effected by its union with the geological survey, &c. (*die geologische Anstalt für Preussen*). At Freiberg I happen to know, from statements which have been published, what the expenses of the school are, the whole there

being paid by the State, and a certain proportion being repaid by the fees received from the students; but a very large staff of professors is kept on foot there, and the expenses altogether, considering the value of money in Saxony, are very considerable.

2457. With regard to the mining inspectors of this country, is there any connexion between Jermyn Street as a school, and the inspectors of mines?—None whatever.

2458. So that your pupils do not obtain those posts?—None whatever.

2459. There is no patronage of that kind?—Not the slightest; on the contrary, the Parliamentary Commission required that the Home Office should appoint no one who had not been a certain number of years actually managing a coal mine, so that none but really practical colliery viewers are appointed to those posts.

2460. (*Marquis of Lansdowne.*) Those subjects of mining and mineralogy involve the application of a good deal of previous knowledge technically to particular subjects, I presume?—The study of mining needs practical observation; mineralogy requires that a person should come prepared with a certain amount of geometry and algebra, geography, and chemistry.

2461. And do you consider that your students at Jermyn Street come to you prepared with an adequate amount of that kind of previous knowledge?—As a general rule they all come very well prepared in chemistry, because most of them have attended the courses of Dr. Frankland.

2462. (*Mr. Samuelson.*) But those courses are a part of the mining school?—They are at present; by the arrangements of our curriculum or course of lectures the students do not come to me for mineralogy until they have passed the course on chemistry.

2463. In saying that the mining schools abroad are largely endowed by the respective States, I suppose you confine that statement to those schools which you call academies?—I think they receive a large sum from the State, and I include the Ecole des Mines, which is a central school. I mean it is termed a school, but I would rank it with the academies.

2464. Assuming that this Commission were to recommend an assessment for the creation of local schools, do you think that such a plan would meet with much opposition or not from the owners and lessees of mines?—I think that in the districts with which I am chiefly acquainted it would not.

2465. Could you specify those districts distinctly?—Cornwall for one, and the North of England, the Newcastle district. Such very handsome offers have been made to endow schools if they could only get a fair start, that I think there is a feeling in a great number of persons that something should be done, and I believe that many of them would be ready to subscribe.

2466. Those would then be districts in which compulsory assessment would be least needed?—Undoubtedly it would be least needed in them.

2467. (*Chairman.*) Are there any other points upon which you would wish to give the Commission information which has not been brought out in your evidence?—No, I think not, as far as I recollect; but I beg leave to hand in a schedule of the subjects taught, and of the lecturers at the Academy of Mines of Freiberg [*see below*], as showing what is deemed desirable in a locality where the whole of the subjects necessary have to be taught in a single establishment.

SCHEDULE HANDED IN BY WARINGTON W. SMYTH, ESQ.

*Subjects of instruction at Royal Mining Academy, Freiberg, Saxony.*

Mathematics, 1st part	Prof. Junge.
Descriptive geometry	do.
Mathematics, 2d part	do.
General elementary mechanics	Weisbach, sen.
Elementary mine mechanics	do.



Mining machinery, 1st course	- Prof. Weisbach, sen.	Art of mining, 2d part	- Prof. Gätzschmann.	W. W. Smyth,
Do. do. 2d course	- „ do.	Surveying ( <i>Markscheide kunst</i> )	- „ Weisbach, sen.	Esq., F.R.S.
Drawing	- „ Heuchler.	Practical do.	- „ Junge.	
Theoretical chemistry	- „ Scheerer.	General metallurgy	- „ Fritzsche.	5 July 1870.
Practical chemistry	- „ do.	Iron metallurgy	- „ Scheerer.	
Analytical chemistry	- „ do.	Assaying, dry way	- „ Fritzsche.	
Mineralogy	- „ Breithaupt.	Do. wet way	- „ do.	
Mineralogical practice	- „ Weisbach, jun.	Blow-pipe assaying	- „ Richter.	
Theoretical crystallography	- „ do.	Mining law and mine business	- „ Gerlach.	
Geology ( <i>Geognosie</i> )	- „ Von Cotta.	( <i>Geschäftstyl</i> )	- „ Gottschalk.	
Palæontology	- „ do.	Book-keeping	- „ Prölss.	
Mineral Repositories ( <i>Erzlagerstätten lehre</i> )	- „ do.	French language	- „	
Architecture ( <i>Civilbaukunst</i> )	- „ Heuchler.			
Art of mining, 1st part ( <i>Bergbaukunst</i> )	- „ Gätzschmann.			

Private Lectures.

History of architecture	- „ Heuchler.
Chemical technology	- „ Ruhe.

The witness withdrew.

Adjourned to Friday next at 11 o'clock.

No. 6, Old Palace Yard, Westminster, Friday, 8th July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

SIR RODERICK IMPEY MURCHISON, Bart., K.C.B., D.C.L., F.R.S., examined.

2468. (*Chairman.*) You are Director of the Geological Survey and the Royal School of Mines?—Yes; Director-General of the Geological Survey of the United Kingdom, and Director of the Royal School of Mines.

2469. Has your opinion ever been taken as to the proposed removal of the educational branches of the Royal School of Mines from Jermyn Street to South Kensington?—Never; and I wish now to place on record my protest against the scheme for breaking up the Royal School of Mines, and to express my surprise that such a plan should have been contemplated without consulting myself and the council of lecturers in our establishment. I may add, that the first intimation to carry out a scheme for the removal of certain professorships of the Royal School of Mines from Jermyn Street to South Kensington, appeared in the memorandum prepared by Mr. Henry Cole, as well as by the evidence given by Capt. Donnelly before the Select Committee of the House of Commons in 1868, presided over by Mr. Samuelson.\* On that occasion neither was I called upon to give any opinion, though the dismemberment of the establishment, which I had directed for 14 years, was manifestly contemplated. It was then too evident that the great change to be made in the Royal School of Mines had been pre-arranged by certain authorities, without any reference to myself. Thus, Capt. Donnelly, who occupies the post of Inspector of Science at South Kensington, when questioned upon this point, said, that the “best plan (speaking off hand) would be to ABSORB the Jermyn Street Establishment.”

2470. Has it been more than a mere suggestion, or have any steps ever been actually taken with a view to carry the removal into effect?—No measures that I know of have been taken, but if you will read the evidence as given before Mr. Samuelson’s committee, you will see that in the memorandum of Mr. Cole it was also very clearly delineated.

2471. What in your opinion would be the effect of the removal of that institution?—The abolition of the Royal School of Mines, after nearly 20 years of successful teaching, would be, in my opinion, a retrogressive and false step in the cultivation of science. By way of illustration, I may state that the School of Mining and Practical Geology of Harvard College, in Massachusetts, and the School of Mines at Columbia College, New York, have both been lately established upon the same plan as our own; in the latter school they have, indeed, adopted the prospectus, with very slight modification. At the present moment the dominion of Canada is considering about the establishment of a mining school in conjunction with the Geological Survey of Canada and its museum at Montreal, thus adopting our scheme in its entirety. In Victoria, also, the Government, upon my recommendation, are establishing a like School of Mines at Ballarat.

2472. Could any of the subjects taught in the Jermyn Street establishment be more efficiently pursued if greater accommodation could be found?—If my own views could be carried out, I should like to see two houses in Jermyn Street rented or bought, wherein to establish sufficient laboratories for those professors who require more space for their teaching and illustration; viz., those of natural history and physics. I do not now advert either to chemistry or metallurgy, because we have for some years depended, as to the first of these sciences, on instruction given in another and separate building, and in respect to metallurgy, which I hold to be an essential part of any school of mines, I know from Dr. Percy, who has so successfully taught it in Jermyn Street, that a small amount of additional accommodation will perfectly satisfy him. I may here observe that, in an official letter to the Council on Education, I have already specified one capacious house in Jermyn Street, which can be had at a rental of about 1,000*l.* per annum, in which the Geological Surveyors’ and the Mining Record Office might be perfectly accommodated. I would here particularly call the attention of your Grace and the Commissioners to the fact, that the size and central

Sir R. I.  
Murchison,  
Bart., K.C.B.  
8 July 1870.

\* See Report from the Select Committee on Scientific Instruction, pp. 392 *et seq.*; and especially Capt. Donnelly’s answers, Nos. 643 to 648.



Sir R. I.  
 Murchison,  
 Bart., K.C.B.  
 8 July 1870.

position of the theatre in Jermyn Street enables 600 artisans to attend the evening lectures, which, to the great honour of the professors, are given by them. These lectures, which are universally acknowledged to be most instructive and useful, are given in a central position, which working artisans can easily frequent. The masses of men I now allude to nearly all come from central London, and can never be assembled in a suburb of the metropolis. The abolition of these lectures would be a most ungracious and untoward act to the working men.

2473. Have you any suggestion to make, by which the Geological Survey of the United Kingdom, the Geological Museum, and the Royal School of Mines, could be rendered more efficient as a co-ordinate body, having one great national object in view?—Presuming that the Government will not find space in Jermyn Street to build such laboratories as I advocate, then some of those subjects to which I have alluded must be taught elsewhere. The School of Mines, however, might be retained as such, even when so limited; and if additional house-room in Jermyn Street were provided for the Survey and Mining Record Offices, and the small addition required for metallurgy, which, I repeat, is an indispensable branch of any school of mines, not only would the progress of the establishment, although thus restricted, be materially aided, but all immediate and pressing wants would be provided for. It is, however, to be clearly understood, that no school of mines can be complete without the services of a distinguished chemist, not only for that instruction, without which the courses of study in our establishment cannot be commenced, but also for the purpose of analyzing specimens of rocks before they are definitively classified and placed in our museum. I may add, that this process is now occasionally done by Professor Frankland, and was also done by Professor Hofmann. So also is it essential that the Geological Survey and the Museum should have its palæontologist. In conclusion, I may call attention to the established fact, that the Geological Survey, the Museum of Practical Geology, and the School of Mines have worked efficiently for nearly 20 years, during 15 of which I have been the Director; and I emphatically deny that, under such eminent men as its present professors, anything but disadvantage can be attained by breaking down one branch of this well-cemented public body. The Royal School of Mines is, in short, a public institution, which will always serve its legitimate purpose, if not commingled with other public teachings, which have nothing in common with it. A great polytechnic school or college, which will, I have no doubt, be established at South Kensington, is doubtless of vast importance in the general scheme of national education; but I contend that for many a year to come the Geological Survey of these Islands, in a broad sense of the words, must be a great and progressing national institution; for, as soon as the outlines and characters of the palæozoic, mesozoic, and tertiary rocks shall have been defined, we have then to develop the superficial deposits which are of such vast importance to the agriculturist.

2474. (*Mr. Samuelson.*) Is it within your recollection that you were requested to give evidence before the Committee of the House of Commons over which I presided, and that, owing to some engagements of yours abroad, you were unable to attend?—I have no recollection whatever of having been requested to attend.

2475. Are you aware that the plan which was presented by Mr. Cole, was so presented upon the suggestion of one or two members of the Committee, and not of his own accord?—I know nothing of that plan, but what I saw in the Report of the House of Commons' Committee.

2476. With reference to the alleged want of accommodation in Jermyn Street, is it the case that Professor Frankland and Dr. Percy have both lately made representations with respect to the want of space there?—I have heard that Dr. Frankland did,

and I have also heard something of a report; but what I have given in my evidence I had from Dr. Percy himself, i.e., that he does not want more than a very little extra accommodation, which could be got in Jermyn Street. I have had no communication with Mr. Cole or any person about what is going on upon this subject at South Kensington.

2477. Has no written communication been made to you on the subject of the want of space in Oxford Street, for the Royal College of Chemistry?—I am speaking of the Royal School of Mines. With regard to the Royal College of Chemistry, I have known for some years that Professor Hofmann and Professor Frankland would both have liked to instruct a much greater number of persons in the science of chemistry than they have laboratory room for there. That they have not had sufficient space there I have known for some time; but what I maintain is, that, such as it was, the chemical instruction was quite enough for all our wants in the School of Mines; it has been admirably conducted for our object, and not one inch more space was required for anything connected with our mining establishment.

2478. In the event of the College of Chemistry being retained solely as an adjunct to the School of Mines, and its being necessary to establish an independent school of chemistry elsewhere, would not that very considerably increase the expense which would be incurred by the Government?—I presume that you suppose that, with the Royal College of Chemistry in Oxford Street, there is to be also a more extensive chemical establishment at South Kensington.

2479. I am not referring to any establishment specially, but if it be the case that the space is not sufficiently large now, and the accommodation in other respects not sufficient for the School of Chemistry as it exists, then if that school is in future to be devoted solely to the purposes of that part of chemical instruction which appertains to mining, I suppose this space would be required elsewhere for the general chemical students, who now, in increasing numbers, go to the School of Chemistry in Oxford Street?—The professors of chemistry would be better able to answer that question than myself.

2480. Has the opinion of the council of professors been taken on the subject of the removal of the School of Mines from Jermyn Street to some other locality?—Not officially.

2481. (*Dr. Sharpey.*) I believe that in the course of the survey it is desirable to have chemical analyses and examinations made of the products of the survey?—Yes.

2482. Has there ever been any difficulty found in getting them executed?—Whenever I have requested analyses to be made, whether by Professor Hofmann or by Dr. Frankland, the requests have been complied with; but I know very well that practical geologists in the field have desired that there should be much more done in that line than has ever been found to be practicable, and I agree with them.

2483. (*Professor Huxley.*) Is the plan to which you refer that which is contained in the Appendix No. 11, to the report of Mr. Samuelson's committee?—It is in the memorandum which Mr. Cole put in. I think the object is very clearly shadowed forth in it, and in the other evidence to which I have already alluded.

2484. I have here the report of the Scientific Instruction Committee of 1868, of which Mr. Samuelson was chairman, and all that I find bearing upon the point which you speak of, is a paper handed in by Captain Donnelly called "Memorandum of suggestions for enlarging the system of State aid to scientific instruction, drawn up in accordance with the instructions of the Lords of the Committee of Council on Education;" is that the document to which you refer?—Yes. I have already referred to that part of it to which I specially object.

2485. I do not perceive that Mr. Cole has anything to do with it?—I refer to the document signed "H. Cole," page 392.



2486. There was one statement which I would venture to ask you to make a little modification about, that was that the working men's lectures are no part of the official duties of the professors; I think they really are part of their official duties, are they not?—They were not so in the first instance, and then very kindly the professors volunteered to give the lectures.

2487. If you will allow me to explain, I think I may recall to your recollection, as a matter of fact, that the giving of one lecture on the part of each professor is a portion of our original constitution, but the enlargement to six is a voluntary thing, so that it is really a part of our official duty?—Then I thank you for that, and I will take care to amend it.

2488. (*Professor Stokes.*) Were you present at that meeting of the council of professors, when inconvenience was expressed from the local separation of the chemical branch of the School of Mines from other branches?—Certainly, at our last meeting of the professors, at which I presided, I distinctly asked that question of Dr. Frankland, whether all the essential parts of chemistry being taught at South Kensington instead of this place, which was then talked about, he could give us the same reports upon the progress of our pupils as before; and whether the thing could be carried on in conjunction with us as heretofore, and he said decidedly it could be so.

2489. My question had reference rather to the existing Royal College of Chemistry; and it was whether any inconvenience was experienced, as arising from the separation of that, which is in Oxford Street, from the Museum?—It was found quite impossible to carry on chemical investigations and instruction in our museum; there is no space for it.

2490. My question was rather with regard to the instruction of students. Of course chemical specimens could be carried about, but the time consumed in passing from one place to the other was so much taken from their time of study, was it not?—Yes. But, in correcting my evidence, it is right to state, that I have altered my answer from no to yes, because, from my imperfect hearing, I misunderstood the question.

2491. (*Dr. Miller.*) I think that the point that we understood Professor Stokes to put was, whether it would not be more convenient if the laboratory and

lecture room were all under one roof, so that the students should not waste time in going backwards and forwards from Oxford Street to the Museum; that, I suppose, there cannot be a doubt of?—There can be no doubt that, if we had a building twice as large as our own, unless there could be space for the fumes which arise from chemical analyses, which are very objectionable, we could not have it of course in the same building; but as I said before, it has gone on remarkably well since the removal of the chemical instruction to the Royal College of Chemistry.

2492. (*Chairman.*) If the additional buildings which you think desirable were procured, would it be necessary to pull them down and rebuild?—Certainly not, for the purpose of offices only. The only object I have in view in the first instance is to give us, what is absolutely essential, a place for a great number of additional surveyors coming up to town to finish their maps. You are aware that the number of surveyors has been very much augmented, and we have only one little room at the extremity of the Museum, which you have inspected yourself, and which I was happy to point out to your Grace, where it is utterly impossible that all those maps should be packed up, and displayed upon tables, and corrections made in them, and that in that one single room there should be space for those subjects, and also for the accommodation of the Mining Record Office, and the Director of the Geological Survey of England and Wales. As I stated before, from the gradual advances in metallurgy, we want some space; and it is not at all necessary that a house should be reconstructed for the offices; whilst the enlargement of the metallurgical laboratories would be a separate addition. What we now absolutely want is space in which the surveyors can construct their maps without being sent to their lodgings to work, in which case we have no sort of control over a considerable number of young men.

2493. Would it not be of importance that they should all be in one large apartment, and not scattered about in a number of small rooms, as is probably the case at present?—I can imagine that a building constructed for the purpose would be better, but as it is we should be very well satisfied if we had any house in which the surveyors could be superintended.

The witness withdrew.

LIONEL BROUGH, Esq., examined.

2494. (*Chairman.*) I believe you are an inspector of mines?—Yes.

2495. What is the district which you inspect?—It is called the South-western District of Great Britain, including a portion of Wales, the whole of Monmouthshire, the Forest of Dean, portions of Breconshire, all Gloucestershire, all Somersetshire, and a mine or two in Devonshire, one of which is shut up—that comprises the whole of my district.

2496. Does your district comprise a variety of mines, coal mines, copper mines, and lead mines?—Only coal and ironstone, no others. The ironstone of the coal measures.

2497. Are copper and lead mines not inspected?—Copper, lead, tin, and most other metals, are not under any Act of Parliament whatever, but coal and the ironstone of the coal measures are subject to inspection.

2498. In any of the mines which you inspect, have you ever found any persons employed who have been educated at the School of Mines?—I have not met with any that have been educated in the Royal School of Mines managing collieries. A great many metallurgists have been occupied in my district, but I have had none from the Royal School of Mines occupied in management. From a local school I have had in my district young men who have undergone a certain course of education in the Bristol mining school, and they have turned out remarkably well.

2499. Are they superior to the ordinary class of managers?—Seeing that they have all been working men I could not say that they are superior to the educated class, but it has greatly added to their value.

The education they have received in that school in Bristol, and another in Glasgow, has produced excellent working men for sub-officers. The one in Bristol I can speak to, because I was one of the examiners for some years whilst it lasted. It no longer exists now under the patronage of the Government, that is to say, we have no stipend from the Government, and all the large subscribers have withdrawn their subscriptions, and finally I did the same, because we could not go on without funds. Still the school has got embodied in the trade school as one of their classes, but without the paid mining master that we had in former days, as far as I know.

2500. Do I understand you to say that there is no mining master now?—There is a young gentleman who teaches on behalf of the trade school, not for the Government, and they do not get the number on the class that they used to get when it was a school supported by public contributions.

2501. What led to its discontinuance?—The want of funds, I believe.

2502. Was the school supposed not to be rendering sufficient service?—The school rendered considerable service, inasmuch as I could point out several young men who are managers who had been formerly workmen, working at night and going to that school in the day; but the subscribers were principally the proprietors of collieries, but gradually they withdrew, until we had no funds at all, and my small amount of five guineas per annum I withdrew also, because it was no use.

2503. There was a Government subsidy, was there

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8 July 1870.

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8 July 1870.

not?—As long as we had a certain number of pupils the Government paid a certain amount for the mining master.

2504. Then the Government assistance was not withdrawn until the assistance from private sources had been previously withdrawn?—Not till that was withdrawn, as I understand.

2505. The private subscribers probably were of opinion that the results were not of sufficient importance to make it advisable for them to continue their subscriptions?—I rather think that they thought more of their money than of the utility of the school. They dropped off one by one until no subscribers were left at all but myself, as I was told, and then I abandoned it also.

2506. Have you come to the conclusion that the managers of mines generally have not received a satisfactory amount of preliminary training?—I would not like to say that, because I may say of my own knowledge that a great number of the managers of mines are well-educated men, but there are still many who have not received adequate information for the important duties which they have to perform. I should like, if you will permit me, to quote an example. Some time ago I had occasion to ask a manager whether he was acquainted with the law of Mariotte and the law of Gay Lussac, and he replied that he had never heard of them. Those two physical laws entirely govern the rules laid down for the ventilation of all collieries, and here is a man in charge of one who had never heard of such natural laws. I think that that was a want of education so remarkable that I cannot refrain from quoting it at this moment. Therefore, I should infer from that, and it is to my knowledge, that there are numbers in a similar state of ignorance. I believe that we want a better class of education for our viewers, in such a manner as the late Mr. Nicholas Wood had originally designed in connexion with the Durham University, but it never was carried through, it fell to the ground; but still such a mode as he pointed out, of a class in connexion with the Durham University, or another university, would answer. After young men had been in the pit two or three years, or before they went into the pit, let them acquire a certain amount of scientific knowledge. I look upon it that that would greatly advance the safety and economy of coal mining in this kingdom.

2507. (*Mr. Samuelson.*) In speaking of the withdrawal of the subscriptions, you made use of the term proprietors; by proprietors did you mean lessees of collieries?—Yes, lessees. I did not refer to the lords of the soil, but to the lessees of the coal.

2508. Had any support ever been derived by the Bristol school of mines from the proprietors of the soil?—I think none.

2509. At no time?—At no time in my knowledge.

2510. Do you know whether any grounds were alleged for the withdrawal of those subscriptions, for instance, that the school was not situated in a district sufficiently central to enable the workpeople to attend it?—I think there might have been a great deal in that. If the same school had been situated at Cardiff, Newport, Swansea, or Merthyr, it would have had more attendance and probably more support. We had many Welsh boys in the school—indeed there were more Welsh than any other nationality—but it was a long way for them to come, and expensive living in Bristol. Therefore, if this school had been situated in any one of the great centres in Wales, it certainly would have had a better attendance.

2511. In point of fact, the youths were obliged to leave their work entirely for a time in order to attend the school?—Exactly so.

2512. Assuming schools or classes in mining to have existed in the other places which you have named, would it have been possible then for youths, engaged practically in mining, to have attended evening classes?—It would have been much more easy for them to have done as they did in Bristol, to work at night in the night shifts and attend the day

classes, because in the case that you put, the mining master would require to be late at night teaching; whereas, if the mining classes were held throughout the day, men working eight or nine hours during the night can very well attend a day class for three or four hours, and they would willingly have done it if the school had been in a greater centre, I think.

2513. You are aware, no doubt, that amongst the subjects for which payment is made on results by the Science and Art Department of South Kensington, mining and cognate subjects are included?—I was not aware of that. I have had so little to do with any Government matters, except being merely an inspector of mines, that that is an arrangement of which I was not previously aware.

2514. Within your district are there any classes at all in mining?—Not now.

2515. I suppose from that you except the classes in mining which are held in the trade school at Bristol?—I know something of the classes in the Royal School of Mines here, and they are most appropriate for teaching, and we in Bristol endeavoured to follow in their footsteps as much as we could.

2516. But did I not understand you to say that classes are now being carried on as part of the curriculum of the trade school in Bristol?—There is a class, but it is more for the purpose of applied mechanics than for mining; it is a portion of the curriculum of the present trade school in Bristol, but it bears no comparison with, and does not teach all the subjects that were taught in, the mining school in the day when I assisted at the examinations. Still useful knowledge is taught now in that class; but as I have nothing more to do with it, and as it simply belongs to the trade school, I, of course, do not attend it. I formerly merely attended the mining class of the trade school two or three times a year to examine the young people in mining matters.

2517. What are the subjects bearing upon their employment which you think should be taught to young working miners?—Young working miners should have as much arithmetic as they could possibly acquire, and our young men at Bristol were taught algebra, and some of them turned out remarkably able algebraists; chemistry and physics are essential: organic chemistry, touching the gases that they meet with under ground; physics, respecting the density, pressure, temperature, and movement of the air, and so on. Geometry is very necessary, with plane and spherical trigonometry, on account of surveying. I think that that would be all that we would teach them, but the viewer class, that is, the head officers, would have to undergo a very different curriculum altogether.

2518. Before you come to the viewers, is there not the class of overmen also for whom you might wish to provide some different education from that of mere working miners?—Yes, those are the class that I am now speaking of, to provide a certain amount of education for working miners, in order that they should be made overmen.

2519. What you have specified you think would be sufficient to qualify working miners to become overmen?—I think so.

2520. With respect to viewers, what course would you recommend?—That would be a very different subject altogether?—I think that the viewer should go into mathematics as far as a full acquaintance with algebraical calculation goes, and higher up again, that he should get into fluxions and the differential calculus. There are often difficult calculations to be made.

2521. Could you give instances of this?—It is difficult to give instances at the moment, but, for example, the change in the volume of air by temperature, and so on; but there are many calculations that I should be unable to specify without more consideration. Then geometry, as far as the books of Euclid that are mostly read; geology and mineralogy, as a matter of course; and natural history as far as it would bear upon palæontology; and I think that a viewer should be acquainted with as much chemistry and physics as it is possible for him to acquire in the short time of two



years or so, or say three years. I think that that should be a viewer's education.

2522. Was any attempt made in the mining school at Bristol to give education of so high a class as that which you have specified?—Not so high. Geology and mineralogy were taught, and rudimentary chemistry also, an acquaintanceship with such physical laws as was easy for them to acquire; but we did not go higher than that with working men; we thought that sufficient to make good under officers.

2523. You have recommended that a mining course should include or presume a considerable amount of mathematics?—I think so, for the high class of officer, the viewer.

2524. Are you aware that in the Royal School of Mines mathematics is never taught nor required?—I am aware of that, but still in the absence of that they have turned out very useful men, but a viewer who has to manage, especially fiery collieries, would be all the better for the whole of that knowledge; it would enlighten his mind very much, and enable him practically to apply that knowledge.

2525. Did I understand you to say that amongst the viewers of your district there are none or scarcely any who have passed through the Royal School of Mines?—Not in my district. I have not one pupil of the Royal School of Mines a manager, but I have some of the pupils of the Bristol school.

2526. Your district is essentially a district of fiery mines, is it not?—Yes, essentially so.

2527. Can you account for the fact of none of the viewers of your district having availed themselves of the instruction to be obtained in the Royal School of Mines?—I think that the pupils of the Royal Mining School have got scattered more abroad in the British colonies; they have sought for employment abroad more than they have at home.

2528. What is the reason of that?—Probably the better emolument and the adventurous spirit of young men generally; they like to get abroad.

2529. But do you think that there is a more adventurous spirit amongst educated young men than amongst uneducated young men?—I should hardly be able to say that, for we have the proof that it is not so by the immense number of miners now going abroad. I have met with Cornish and other miners all over Spanish America, and for the most part doing well.

2530. Does it not seem strange that those young men should all have found employment abroad and none of them within your district?—Probably they had not worked in the coal mines of Great Britain previous to coming to the Royal School of Mines. It is essential that a head viewer should also be practical as well as well educated, because a great colliery proprietor would not employ a well-educated man for the viewer of his mines, unless he had also been practically brought up under ground. And the difficulty that I understand would be how to apportion the time for the chief viewers, at what period they should be under ground and at what period at college.

2531. Have you considered the difficulty at all with a view of suggesting some course?—I would suggest that they should undergo their curriculum first, for a few years, and then go under ground; that they should commence as collegiate students earlier than they do at the universities generally.

2532. Do you think that if young men who have gone through the mining course can find employment abroad, as you say they can, they would be willing to work practically in a mine in England after having undergone such a course?—The viewer class for the most part are well-doing people, and they do not work with their hands, they simply work with their judgment, they do not take tools in their hands, they do not actually mine with implements; but the overmen class do occasionally, with a view to instruct young colliers.

2533. But is it not the case that the viewer class is in a great measure recruited from the overmen class?—It does occur, but it is an exception to the general

rule. The viewer class, those who have the command and management of large collieries, are brought up viewers. Very able workmen who become overmen sometimes lead up to become head viewers themselves, if they are especially clever men.

2534. Speaking of those who are educated to become viewers, what is the course of education which they ordinarily undergo for their profession?—They get into the pit very early, and they never get out of the pit, they never have the chance of a higher order of education after that.

2535. Are they apprenticed to other viewers?—For the most part they are apprenticed to viewers of eminence, like Mr. Forster of Newcastle-upon-Tyne, the late Mr. Nicholas Wood, Mr. William Armstrong, and other eminent men of that class, and once articulated to them they get at pit work, that is to say, learning and assisting the chief viewers in the pit work, and they never have the chance of acquiring a university education afterwards.

2536. (*Dr. Miller.*) How early do those lads go under ground?—Generally at 16 or 17. The young people become articulated at that age, or sometimes later, because they must have some education before a viewer will take them as articulated pupils, but they do not get that higher course of education which would be so necessary to help them in their future occupations.

2537. (*Mr. Samuelson.*) Have they ordinarily any knowledge at all of the sciences bearing upon mining before they enter upon their apprenticeship?—I think not, they get a good home school education, some of them in grammar schools, and so on; a few get a smattering of Latin and Greek, but they get no scientific education, as a rule, before they are articulated to a chief viewer.

2538. Have you at all considered the converse course to that which you have recommended, namely, that young men should go under ground for a year or two, and afterwards enter, for one or two years, into a college of science or mining school, as the case might be?—I began by saying that it was difficult for me to arrive at any conclusion as to which would be the best, but upon the whole, I think, that it would be better for them to undergo their curriculum first, and then go to the pit.

2539. But at any rate, whichever of the two courses may be adopted, you have no hesitation in recommending that they should at some time pass through a course of scientific instruction?—Yes, I most strongly recommend a higher order of scientific education than is general at the present day. I think it would be of the utmost value, both for the economical working of the mines and for the safety of the miners.

2540. Amongst the lessees of collieries, do you find much scientific knowledge of their art?—Occasionally a considerable amount, for example, the Messrs. Knowles, of Lancashire, who are colliery proprietors to a very large extent, all have some amount of scientific information, which I have no doubt they have studied hard to acquire, and holding and using immense capital they have improved their colliery operations; and others there are of that class, but I should be unable at this moment to mention them all. There are a few in Wales who have acquired a good deal of scientific knowledge by hard study at home after their work has been completed, but then that is not the right sort of scientific education after all; science should be taught, and not acquired by excessively hard reading and study by the young people themselves after the labour of the day is concluded.

2541. I presume you would never expect that any great number of men would educate themselves in that way?—I do not expect any great number of men to educate themselves, I do not think it is likely; still some do. They begin to earn their bread and there they remain.

2542. How long have you been the inspector of the south-west district?—12 years next November, and I was three or four years the inspector in Staffordshire before that, when one of the body of inspectors died,

*L. Brough,  
Esq.*

8 July 1870.



L. Brough,  
Esq.

8 July 1870.

Mr. Herbert Mackworth, and the Government sent me into his district from South Staffordshire.

2543. Was the state of scientific education in Staffordshire very much better than in the district in which you are now?—Certainly not, not by any manner of means. I left it, however, much better than I found it, and it has been getting better ever since. There is an evident desire now to learn there.

2544. Is there not a great difference, speaking generally, in the amount of scientific knowledge possessed by the viewers in different parts of England and Wales?—It is said that Northumberland and Durham would claim to be the highest educated class of viewers in the kingdom.

2545. Assuming that the same amount of education prevailed in other districts, without specifying them, do you think that amongst other advantages this would be a result, that the loss of life in collieries would be very much less?—I think so. I think that science would so bear upon the distribution of air and other operations under ground as to add largely to the saving of human life.

2546. In confirmation of that, would it not be fair to say that, taking equally fiery collieries in the north of England and in other parts of England, the loss of life is less in the north of England, in proportion to the quantity of coal worked, than it is in other districts?—Of late years that has been the case; the loss of life in proportion, to any given quantity of coal has been less in the north than it has been in Wales or Lancashire.

2547. The loss of life, in addition to that resulting from explosions, also arises, does it not, in a very considerable proportion, from the fall of the roofs of mines?—Yes, more people are killed by the fall of materials under ground, roofs and sides, &c. (I should think double the number, taking the average of any 10 years), than are recorded to be slaughtered by fire-damp.

2548. (*Dr. Miller.*) The public in general do not hear of accidents of that nature?—The public in general do not appear to me to take much interest in the matter. They are shocked when a great calamity occurs, but they forget it again directly.

2549. (*Mr. Samuelson.*) Would you make the same statement with respect to accidents of that kind as regards the value of a more intimate acquaintance with science on the part of viewers?—I think it would be fair to make the same statement; a scientific knowledge would make them better engineers under ground. There is a sort of civil engineering going on continually under ground, there is the supporting of roofs in a proper manner to work at proper widths, and distributing them in such a manner that the least number of accidents from the fall of roofs should occur; and if science would help in one way it would help in another.

2550. That is a department which is in great measure in the hands of overmen, is it not?—It is in the hands of overmen to a certain extent, under the authority of the viewers, and still more of the deputy overmen. In a pit there may be two overmen, a night overman and a day overman, but each of those will have six or eight or ten deputies under him. One man could not do all the duty, and therefore it is necessary that he should be supplied with assistants, who are called deputies, and in time they become overmen, some of them.

2551. Do you think that if the viewers were more generally men of scientific acquirements, they would insist upon the qualifications of the overmen and the deputy overmen being also more satisfactory?—I think that if the viewers themselves were scientific men they would know the value of science, and they would like their under officers to possess some portion of the same knowledge, not much indeed of the higher order of education, but still some.

2552. Do you think that if the viewers were more impressed with the value of science, schools such as the Bristol mining school would receive more support?—I am not quite sure of that, I rather think that the

higher class viewers were never very fond of local mining schools.

2553. Are you aware what is their objection to those schools?—It is rather difficult to answer that question. It may be that it would throw into the market a lot of half-educated ability that would compete with themselves. Those questions are very difficult to answer.

2554. At any rate, if the proprietors or lessees were convinced of the value of science with reference to their art, they would be more disposed, would they not, to encourage local schools?—I think that the lessees of the great noblemen and the wealthy landed proprietors think on that subject very much as I do myself, that there is a necessity for more scientific teaching and a greater amount of scientific knowledge, and that their property would be rendered more valuable by it.

2555. Do you think that that feeling has sprung up recently?—I think it may be said to have sprung up far within the present century, perhaps for 20 to 30 years. It became evident to them that science was necessary for the development of their own mineral wealth, and I think that that is an opinion which is growing with the great landholders every year.

2556. You have stated repeatedly, I believe, in your reports that amongst the working miners there is very great recklessness?—There is that amount of recklessness with us all that familiarity with danger produces, we are all to some extent reckless. They are not more reckless or more wilful or thoughtless than other working men, but constant familiarity with danger does produce an indifference to it, and recklessness naturally follows.

2557. Do you think or not that if they were better acquainted with the sources of danger, and the means of avoiding it, the same recklessness would still prevail?—No, I think not. The more they are educated the more thoughtful they would become, and they would exercise their thinking powers more. The object of working men of all ranks is to get as much money as they can, and to get their day's work completed within as short a time as possible, but give a man education and it sets him thinking.

2558. That would apply as much, I suppose, to primary education as to more advanced education?—Yes, just so; the more thought is developed the better, and thought can only be developed by education.

2559. Assuming local mining schools to exist, are the young men, as a class, sufficiently in possession of elementary education to be able to avail themselves of such schools?—All the pupils of the mining school in which I interested myself had learned to read and write and a certain amount of arithmetic before they came; none of the utterly ignorant ever came near us.

2560. But the number of those pupils, I presume, bears only a small proportion to the total number of miners?—A very small proportion indeed.

2561. Do you remember what was the greatest number of pupils you ever had at one time in the Bristol school?—I think at one time we had 22 or 23, that was the greatest number; but it is fair to say that amongst them were the sons of persons in a higher order of life, for example, a clergyman in the neighbourhood sent a son, and so on. I think about a dozen was our average annual number of real miners who came there to better their education, all the time that I was connected with it.

2562. Your district, I believe, includes Monmouthshire?—Yes; all Monmouthshire, a considerable portion of Breconshire, and a slice of Glamorganshire, and also everywhere south of the Severn Sea.

2563. What is the mining centre of your district?—The mining centre, as a port, is Newport, but probably the great mining centre would be Tredegar, on the edge of Breconshire, inasmuch as it is the largest of the mining towns in the county.

2564. What is the population of Tredegar?—I should think more than 12,000.



2565. The railway communication between Tredegar and the various mines is probably complete, is it not?—It is very ample now as to railway communication; there are railroads in all directions, up every valley.

2566. Have you made any approximate calculation as to the number of miners within a radius of 10 miles of Tredegar?—I might be able to make such an approximation. It would include Dowlais and Merthyr.

2567. Tredegar is within 10 miles of Merthyr?—Yes, within 10 miles.

2568. So that a mining school at Merthyr would accommodate Tredegar?—Yes, very well. Merthyr would be a better centre than Tredegar.

2569. Is not the population of Merthyr about 100,000?—Yes, I should think so, Merthyr and Dowlais together.

2570. And the mining population accommodated by a mining school at Merthyr would perhaps be more than double that number, or quite double that number?—Yes, I should think so, because it is very central and well fed by railways, and it would command the whole of mining Wales.

2571. Who is the mining inspector for South Wales?—Mr. Wales.

2572. Have you had any opportunity of ascertaining his views upon the subject of the necessity of education for miners?—I have not had any means of ascertaining his views, but I should suppose that he would think much the same upon the subject as I do. Probably he might not go to the extent that I do about high education. I rather think he would not, perhaps, go to that extent, but he may.

2573. Do you think that he would agree with you as to the amount of education which the overmen should possess?—I think so, but I have never had much conversation with Mr. Wales upon the subject; we live far apart, and I have not had much opportunity of consulting him. I see but little of him, and therefore I should be afraid to speak to his views; but he is a very sensible and prudent man, and I think that he would go a long way with me.

2574. I suppose that the conditions of Monmouthshire and Wales are very similar?—Very similar; probably Mr. Wales' district is even more fiery than mine, and more dangerous, if possible.

2575. In many cases the proprietors of mines in Monmouthshire are also proprietors of mines in the district of Wales, are they not?—In some cases there does exist that double proprietorship.

2576. Are you aware whether the establishment of a mining school in one of the mining centres of Wales and Monmouthshire has ever been suggested?—It has been suggested many times, but it has never been carried into effect.

2577. By whom has it been taken up?—I have often heard viewers speak of it, and the owners, and I have frequently mooted the question myself to them, but it has never been taken up.

2578. Could you yourself give the Commission any suggestions with reference to the establishment of such a school?—The difficulty with local schools is the mode of furnishing them with means, that is the principal difficulty. The Government could not be expected to support mining schools in all the kingdom, I apprehend, although I wish that there were more like the Royal School of Mines. If they were spotted or jotted over the kingdom, very much good would come out of them.

2579. Do you mean schools of the same grade as the Royal School of Mines, or of a lower grade?—The more schools like the Royal School of Mines the better; but they would not educate the class of people whom you want educated, namely, the overmen class, they are rather too high for them.

2580. Then you would be satisfied with schools of a somewhat lower grade?—Yes, of a slightly lower grade, of the grade of the schools at Bristol and Glasgow; those would be the two models for the establishment, and they are both stopped now unfortunately.

2581. Had you any difficulty as to the supply of teachers in Bristol?—I think there would be no difficulty in getting teachers in Bristol or anywhere else. I think that there would be quite a sufficient supply of teachers for the secondary or lower class. The first-class education for the viewer class is only to be got in connexion with one of the universities.

2582. Or in technical schools of a high class?—Of a very high class indeed.

2583. Do you recollect what was the total annual expenditure in the Bristol mining school?—I cannot inform you; I never had anything to do with the monetary affairs, but the fee for teaching was something remarkably low, about 4*l.* a year, and the laboratory charges of course were added. We had an excellent chemistry master, Mr. Coomber.

2584. Mr. Coomber, who is now the head master of the Trade School?—Yes, and a most excellent master he is.

2585. Have you ever made an approximate estimate as to what would be the cost of establishing and maintaining a secondary mining school in a mining centre?—I have never thought of the amount of money required annually to keep such a school going on, certainly it would require a few hundred pounds at least. The masters must be well paid, otherwise you would not command good men in the capacity of teachers.

2586. Would it be an appreciable per-centage upon the capital engaged in coal mining within such a district, or upon the amount of wages expended within that district?—I think perhaps that the amount of wages would guide us more than anything else.

2587. Comparing the probable cost of such a school with the amount of wages, would it not bear a very small relation to it?—I think so in Wales, on account of the vast amount of wages paid. Taking Merthyr as a centre, the amount of wages paid in cash is enormous.

2588. Do you know what is the amount of wages paid annually?—I should think at Dowlais alone their weekly cash payments must be something like 6,000*l.* or 7,000*l.*

2589. That is to say, the payment in wages of a single iron or coal company is something like 400,000*l.* per annum?—With regard to Dowlais I should not be surprised if it came up to that.

2590. Then the amount of wages paid within the district must be several millions?—Yes, taking as a datum 400,000*l.* per annum, perhaps it would not come up quite so high as that.

2591. At any rate you would say that the cost of maintaining a school of mines would be an inappreciable per-centage upon the amount of wages paid?—Very inappreciable. It would be something that would hardly be put down, it would be so small compared with the vast amount of money paid in wages.

2592. Leaving out the considerations of loss of life and loss of capital through the stoppage of collieries, do you think that in the mere avoidance of waste the cost of such a school would be repaid?—I think so. I have that opinion of the value of education that I think it would amply repay itself in time, but it takes time to prove those matters. For example, in the case of the mining school in Jermyn Street, one generation could hardly tell us what value has resulted from it.

2593. Do you think it would take one generation before the cost of the establishment and maintenance of such a school would be repaid?—I think it would be felt earlier in the elementary school than it would be in the higher school, because more people would attend; the number of overmen greatly surpasses the number of head managers, and the workmen again are in multitudes.

2594. But with respect to the education of the workmen, do you think that any larger number would be able to avail themselves of such a school in the present state of elementary education?—I think there would be in my district a desire for education; the men

*L. Brough,*  
*Esq.*

8 July 1870.



L. Brough,  
Esq.

8 July 1870.

that have learned to read and write would be glad to have an amount of elementary science which would enable them to be officers.

2595. Are those men sufficiently numerous to constitute classes?—I should think so. The only trial that I have been acquainted with is that in Bristol, but unfortunately that has not succeeded.

2596. (*Sir J. Kay-Shuttleworth.*) You are aware that mines have recently been sunk below the Permian to a very great depth?—Yes.

2597. Would not the existence of those mines create new problems as to ventilation, and other questions as to the working, which will involve a very high scientific education?—Yes, of course the great depths, the increase of the temperature, and the increased amount of friction of the air itself, would involve a considerable amount of scientific attainment to overcome, and we may have to go very deep indeed.

2598. And upon the degree in which the highest conclusions of pure science are applied to the working of those extremely deep mines will depend the extent to which the coal can be recovered under the Permian?—Yes, we have reason to suppose that the coal under the Permian, even in Britain, may be very deep indeed in places, much deeper than any depth which we have arrived at as yet; hence my advocacy of more scientific knowledge on the part of miners is rendered more urgent from that very cause.

2599. A knowledge of the natural laws affecting ventilation, to which you have already made allusion, would in such cases be extremely important, not only amongst those who plan all the great machinery for the working of mines, but also amongst the viewers and the overmen and the workmen?—Yes, the amount of scientific education that the Belgian mining engineers get is very considerable, and they are enabled to apply those two laws of physics which I spoke of just now, they are perfectly acquainted with them. If I asked a Belgian engineer the question which I asked an English engineer he would have said, "Yes, it was a portion of my curriculum; I had to study those natural laws and work them out, and make myself fully able to go through the whole of the calculations connected with them."

2600. Are you acquainted with the working of the thick mines in Staffordshire?—I had a great deal to do with the thick coal, that is to say, the 10 yard seam.

2601. Has there not been a considerable waste in the working of that coal, which might have been avoided if there had been a better knowledge of mining engineering?—I think there has been a great national loss from that very cause.

2602. And which, if the education of the viewers and lessees of collieries had been conducted as you have advised the Commission it should be conducted, would certainly have been avoided?—Yes, all that lost property would be available.

2603. Then with respect to the fiery mines, I believe it is generally understood that some of the most terrific accidents which have happened in coal mines, have arisen from the sudden outburst of compressed gases?—Yes, often the sudden outburst of compressed inflammable gas,—carburetted hydrogen.

2604. Is there not presented a remarkable problem to the scientific world with respect to the outburst of that compressed inflammable gas, whether any means could be adopted which should meet such formidable emergencies?—Yes, there is a remarkable problem presented, but a problem which no doubt might be solved by a higher order of science than we now possess.

2605. If you could conceive that the great body of the lessees and the viewers and overmen of the mines had a considerable knowledge of scientific laws, would it not be likely that some men of genius would arise out of that body, who would provide in the practical working of mines some remedy for those terrific emergencies of the outburst of compressed inflammable gases?—Yes, I think that with a greater amount of science some man of genius might arise,

and a spark would be suddenly struck from his genius that would enlighten us all, and would teach us that which we do not any of us know at present.

2606. It has been stated to us in evidence that the surveying of mines is conducted with reference to the magnetic north, and not to the true north; you are aware, I believe, of that fact?—Yes, I am aware of that.

2607. Is there a general knowledge of the variation of the needle, and the way in which it affects the accuracy of viewing in cases in which mines are exposed to the inburst of water or any other accident affected by the accuracy of the surveying?—There is more knowledge of the variation or declination of the needle now than there was in the beginning of the century, all the viewers are now acquainted with it; but they should put it down on their maps, they should not only put the magnetic meridian, but also in a dotted line the number of degrees of variation, which may be about 22 at the present day. I cannot say exactly, but it is somewhere about 22 degrees of variation of the needle at the present moment.

2608. Do they practically put that down?—They do not always practically put it down. Many of the leading viewers, both in Wales and the north, dot out the variation, so that if the same plan had been followed, and if it were put down always invariably, they would know what it was 50 years ago or 20 years ago, and so on, and they would know then where to look for a great reservoir of water, if such had existed.

2609. But having their ancient maps planned simply with reference to the magnetic meridian, and not having had the variations correctly laid down in the map, and still going by the magnetic meridian, do they not from time to time encounter extreme danger of tapping some great reservoir of water?—Certainly that danger must sometimes be imminent, and if they do not know the amount of variation when they deal with those excavations, they might suddenly come upon a great body of water without ever expecting it, without ever contemplating that there was such a body of water, guided by the old map of the day without the variation being laid down.

2610. Passing to the present ordinary education of the viewers, may I ask you whether it is not common that a young man having sufficient means is introduced into a viewer's office with a considerable premium, and then in the mines obtains whatever technical education he can secure?—That is the prevailing custom. A young man, the son of respectable parents, will perhaps leave the grammar school of his town or neighbourhood at 16 years of age or so, he might be a year younger or a year older, and he will be bound apprentice to a great viewer, and all chance of high scientific education then is lost; he merely acquires a technical education after that.

2611. What he acquires is the power of surveying in the mine and of plan drawing in the office consequent upon his surveys, and the ordinary practical operations of the working of mines?—That and pitmanship.

2612. But as to any knowledge of the natural laws, and especially any power of scientific speculation, as to the improvement of the methods of mining, he has not the slightest opportunity, except by private reading, of arriving at such knowledge?—I do not see that he has much opportunity of arriving at such knowledge, because he becomes pressed with business, and gets employment; and gets his bread, and all thought of scientific improvement passes away for want of time.

2613. And yet, with a view to the application of the general natural laws to the improvement of mining, such scientific education is of the very highest importance?—I have always thought so myself, and continue to be of that opinion.

2614. Supposing that there were a secondary school of science, with technical classes, in the neighbourhood of the viewer's office to which a young man was apprenticed, and in the intervals of his apprenticeship



he had an opportunity, and it were by public opinion regarded to be a necessary part of his training, that he should avail himself of the opportunity of attending such scientific technical classes, would not that be a very great advantage in his training for the practical duties of his vocation?—Yes, if at that school he were taught a high amount of science, that would be so, no doubt; but men who work very hard get tired, and there is a reluctance on their part to go to school sometimes.

2615. But supposing that public opinion or custom or the law interfered to secure them proper intervals in the course of their apprenticeship for such scientific training, you would think that custom or opinion or the law would be justified in that interference?—Yes, if public opinion would bear more strongly upon it than it has done; and I should like to see public opinion become more developed on that subject. If public opinion were strong, it would be bound to be followed.

2616. And you would desire that any young man who showed higher capacity for scientific attainments should, besides the education which he might, during his apprenticeship, get in a secondary mining school in the neighbourhood of his master, likewise obtain instruction in some central school of science, and of technical instruction, where he might complete his education?—I think it would be very desirable to get such institutions established—that, or previous collegiate education, which is far better.

2617. With respect to the local schools, you have said that at the present moment it has been very difficult indeed to support a school of this character which existed at Bristol by local contributions, even when there was a knowledge that Government aid to that school depended upon the continuance of those contributions?—We found it so. I speak now from experience; we found that all the funds which we could get together were insufficient to carry on the establishment, notwithstanding we had Government support at one time to the extent of 50*l.* or 60*l.* per annum to pay the mining master.

2618. And yet the cost of supporting such schools would form quite an inconsiderable charge upon the average sum paid for wages?—A very inappreciable percentage in the great centres. I should have stated that Bristol was not a very great centre as regards mining operations; in fact, I have already said so.

2619. Supposing therefore that public opinion should fail to secure this form of instruction for young men during their apprenticeship, should we not, having regard, first, to the terrific accidents which occur in mines from the want of proper knowledge, to the great waste of the national resources in the working of such beds as the thick bed of the Staffordshire coal field, and likewise to the problem yet unsolved, of the extent of working which can be carried on in very deep mines under the Permian, would not the Government, in the failure of that public opinion to produce a change, be justified in making some charge upon the wages or upon the capital employed in mining to secure such education for the young men apprenticed to that vocation?—The best plan would be some very small charge indeed, on a ton of coal, perhaps.

2620. But you would approve of some such charge upon either the produce of the mine, the wages, or the capital?—Yes, I would approve of any fair charge, or even tax, if it may be called so, upon coal, or upon the men's wages themselves, to increase the amount of the education of the people. We have not enough of education now, and I want to see it increased in every possible and legitimate way; the difficulty is the pecuniary difficulty.

2621. If the Government, representing the general interest of the nation in the full development of the national wealth, were to make some amount of contribution, would it not be perfectly reasonable that there should be some contribution likewise from those who either own or who work the mines in their respective districts to meet those exigencies?—Yes, certainly it

should be participated in by all; the workman himself, the lessee, and the lord of the soil should all contribute, it should not press more hardly on one of those classes than on the other. A scale might be arrived at by a man competent to make such calculations, and I think there would be no disinclination on the part of the three classes to contribute in such a proportion.

2622. You conceive that it would be in the interest of the workman to be more safe, in the interest of the lessee to get more profit from the working of the mine, and in the interest of the owner that no part of his property should be wasted?—Certainly, that all should be brought to bank, and that no portion of coal ought to be left underground.

2623. That all should pay for those advantages?—Yes, it is national property, and every ton that is buried underground for ever, is a loss to the nation.

2624. (*Chairman.*) Have you formed any opinion as to the amount of salaries which you think the teachers of mining schools ought to be able to command?—That would depend upon the amount of science taught.

2625. In the case of such a school as you would like to see established, say at Merthyr, what salaries should the teacher of such a school receive?—I hardly know how the teachers should be paid. I think that a man capable of teaching such a school, the head master of such a school as Merthyr, with so vast a population, certainly ought to be paid from 250*l.* to 300*l.* per annum.

2626. Could such a school in your opinion ever be made self-supporting by the fees of the pupils?—The difficulty is, that unless those fees are enforced by some law, I think they are not paid up. In one great mining centre that took place, namely, Glasgow; the school fell to the ground, as it did in Bristol; I speak of contributions.

2627. Did that depend solely on the fees of the students?—The fees of the students and the contributions from the colliery proprietors and lessees. That was a school that was well established, and the means at the beginning were abundant for its continuance, but, as in Bristol, by degrees the contributions dropped off.

2628. Are you acquainted with any of the Belgian coal mines?—I have never been occupied professionally in Belgium. I have wandered over Belgium, but I have never been employed in the Belgian coal mines.

2629. Have you inspected them?—Never, professionally.

2630. Are you able to say whether they exhibit evidence of much greater scientific attainments on the part of the manager than is the case in our mines?

I think that they do exhibit every evidence of more scientific attainments, but I do not think that the Belgian mining engineers are so admirably practical as the British mining engineers; those two acquirements, practice and knowledge, must both go together. The Belgian engineers get a good early education, superior to ours I think; but their practical knowledge is not so perfect.

2631. Do you know whether there are as many accidents in proportion in the Belgian mines as in the English?—Two years ago one of my colleagues (Mr. Atkinson) made a calculation from information supplied him to show that for any given amount of coal, say 100,000 tons, got, there were more accidents in Belgium than in Britain.

2632. Do you know whether there are any data for ascertaining whether there is less waste of material in Belgium than in England?—They have a most extraordinary stratification, and their results could hardly be so good as ours, for it is a continuation of zigzags; their planes of stratification are all up and down, and the pit will perhaps go twice through the same bed of coal in sinking.

2633. Have they a greater number of difficulties to contend with?—Yes, their natural mining difficulties are greater than ours, as regards stratification; but they have not so much fire-damp.

*L. Brough,*  
*Esq.*  
8 July 1870.



L. Brough,  
Esq.

8 July 1870.

2634. (*Mr. Samuelson.*) The inclinations of those zigzags are very great also, are they not?—Yes, they are compressed zigzags.

2635. (*Sir J. Kay-Shuttleworth.*) Sometimes like a flash of lightning?—Yes.

2636. (*Chairman.*) Could you point out any instance in your district in which the value of scientific attainments on the part of viewers has made itself manifest?—Yes, I could perhaps name collieries where men with some amount of science are that have shown good results, but it would be hardly fair for me to make any statement of persons or names, because these transactions probably will be read by the public, and it would look on my part invidious.

2637. But you think that there are such instances?—Yes, I think there are. I am quite sure there are.

2638. (*Dr. Miller.*) Are the mines in Belgium more or less fiery, on the whole, than those of England?—On the whole they are less. They have a considerable amount of fire-damp, but taking it altogether they have not the enormous outbursts that occur in Britain, especially in Monmouthshire and South Wales.

2639. (*Mr. Samuelson.*) Is it not the case that, notwithstanding those mines being less fiery, the system of ventilation generally has been perfected in Belgium earlier than in England by the application of mechanical means?—Yes; we have learned from Belgium, to some extent, our mechanical ventilation; we have copied from them their form of the Guibal fan, and the Lemielle, for example, which are most admirable mechanical means of producing a current of air.

2640. Mechanical ventilators were applied in Belgium and in France before they were introduced into the mines in England?—There were some fans in England, the Nasmyth fan, perhaps, before they resorted to mechanical means in Belgium, but they were inefficient.

2641. That mode of ventilation was perfected abroad?—Yes, the machines were.

2642. And generally applied before it was applied to any great extent in England?—Most decidedly, except the "Nasmyth," which, as I believe, was anterior to any really useful Belgian machinery.

2643. In fact its introduction into England is even now slow and gradual?—It has been making great progress within the last three years; mechanical ventilation is now increasing very fast in Great Britain indeed.

The witness withdrew.

Sir WILLIAM THOMSON, LL.D., F.R.S., examined.

Sir W.  
Thomson,  
F.R.S.

2652. (*Chairman.*) I believe you are Professor of Natural Philosophy in the University of Glasgow?—Yes.

2653. Can you give the Commission a general view of the means which the University of Glasgow possesses of promoting scientific instruction?—The means are now being very much improved by the new buildings into which we are at the present time entering. We have not as yet experienced the benefit of those new buildings, but we expect that they will give us very much improved facilities and advantages for the cultivation of science, as well as for teaching in the different departments.

2654. What are those buildings chiefly intended for, for what branches of science?—For all branches of science.

2655. Was the University previously very deficient in proper accommodation?—The accommodation was quite insufficient for the increased number of students, the increased number of professorial chairs, and the vast extensions of modern science.

2656. Can you give the Commission a general view of the professorial staff connected with science at Glasgow?—There are the old four faculties of arts, theology, law, and medicine. The faculty of theology naturally includes archaeological science, philology, and oriental languages. No student is allowed to enter it until he has gone through the full "curriculum" of

2644. But the plans of mechanical ventilation which we are now adopting have been for a considerable period perfected and applied on the continent?—That is the fact.

2645. And that mode of ventilation is all the more requisite, the deeper the mines to which it is applied?—Most decidedly, if there be pits enough; although furnace ventilation is admirable for great depths.

2646. (*Chairman.*) Have you ever seen any symptoms of prejudice against the employment of educated viewers amongst the lessees?—I do not think I have observed that; there is a natural feeling on the part of lessees to get good men at as low salaries as they possibly can, and that over feeling of economy sometimes prevails over the appointment of more scientific people.

2647. Can good viewers command very good salaries?—Very good salaries; the high-class viewers in Northumberland and Durham do obtain very considerable salaries.

2648. Did I rightly understand you to say that in your opinion the proposal to tax coal for educational purposes would not be unfavourably received?—I made use of the word tax, but I also stated that all should participate, the three classes, the proprietor of the land under which the coal lies, the lessees of the mine, and the men themselves, a fair apportionment to each party.

2649. Have you ever had any conversation with persons connected with coal mines upon that subject?—I have not. I have spoken on the subject of laying a small impost upon coal for the purpose of insuring the men's lives underground, some very small amount indeed, which we have no coin to represent. The quantity of coal got in Great Britain is very large now, 108,000,000 of tons last year; an almost inappreciable amount on each ton of that enormous quantity of coal would raise a very large sum. I have often talked with people on that subject, touching insurance, but not touching education.

2650. It is an opinion which you have formed yourself, but without any special communications with persons connected with coal mines?—Without any special communications whatever.

2651. Is there any other matter which you would like to mention to the Commission?—No, I think there is no other matter which occurs to me at the present moment.

arts, which includes classics, mathematics, mental philosophy, and natural philosophy, but not yet natural history and chemistry. The faculty of medicine and the faculty of arts contain in their provinces nearly all of what is commonly called science.

2657. Is natural philosophy at Glasgow included in the faculty of arts?—Yes.

2658. Is the instruction entirely given by professors, or is there any class that might be called a class of tutors?—A recent Act provided assistants to the professors in several departments. Under it the professor of natural philosophy, the professor of mathematics, and the classical professors; also the professor of chemistry, the professor of anatomy, and some of the other medical professors, have official assistants. The official assistants in accordance with the terms of that Act may give tutorial instruction or special lectures; and in many departments, especially in classics and mathematics, the official assistants are very largely employed in conducting tutorial classes.

2659. Are any salaries for the tutors provided from Government sources?—Yes, 100*l.* a year, which is practically very much too small a salary. In most cases, I believe in all cases in which the whole time of the assistant is required, the professor pays a very considerable sum, so much in some cases as to double or treble the income derived from the Government.

2660. Was this arrangement for the establishment



Sir W.  
Thomson,  
F.R.S.

8 July 1870.

of assistant professors or tutors come to in consequence of any recommendation from the university?—In consequence of the report of the commissioners founded on evidence, both written and oral, supplied by the professors, and the other means of arriving at a judgment which the commissioners had taken.

2661. I believe also that some scholarships have recently been founded in the University of Glasgow?—Dr. Neil Arnott has given to the University of Glasgow and to several other universities and institutions valuable donations for the purpose of promoting physical science. To the University of Glasgow he has given 1,000*l.*, and in consequence of its being understood that his wish was to promote science in connexion with medical education chiefly, the annual proceeds have for the present been divided into two equal parts, one to promote higher education in physical science amongst medical students, the other simply for the promotion of physical science; and Dr. Arnott has signified his approval of that division.

2662. Have any other scholarships been recently established?—I have recently myself given the same amount, 1,000*l.*, for the foundation of experimental scholarships, the object of which is to promote experimental investigation.

2663. Are there no ancient endowments for scholarships in the University?—There are many foundations, bursaries, and scholarships, and fellowships, some of which are devoted chiefly to science. But when I was asked with reference to recent scholarships for the promotion of science, I ought to have mentioned what is not called a scholarship, but which is of greater importance than those I have mentioned, the Eglinton fellowships, and the older foundation of Breadalbane scholarships; larger foundations considerably than those which I mentioned first.

2664. Are those fellowships to which you have just referred of considerable annual value?—About 100*l.* a year, I believe, on each foundation goes to science.

2665. What opinion have you formed as to the advantage of the combination of literary and scientific studies?—I believe that scientific studies gain by the combination, and I believe that in point of education the influence of scientific studies on those who prosecute them is very much enhanced by a judicious combination of literary culture.

2666. Do the students at the Glasgow University, speaking generally, combine those two classes of studies?—Yes.

2667. But it is optional with them whether they will do so or not?—To go through the full curriculum for the degree involves a very considerable amount of actual attendance upon classical instruction, and a considerable degree of proficiency in classics, also an attendance upon instruction in logic and mental philosophy, and satisfactorily passing examinations in those subjects. The students of natural philosophy have generally gone through a considerable course in classics and mental philosophy before coming into the natural philosophy class, but it is not necessary that they should have done so. They may enter the natural philosophy class directly and take that alone, without any other class in the university.

2668. But is it not the case that no one can obtain a degree without a considerable amount both of classical knowledge and scientific knowledge also?—It is so.

2669. Do you think it desirable that teachers should also be engaged in original research?—Most desirable. I think it adds very much to the interest with which the students follow the instructions given by the teacher, if the teacher is known by them to be prosecuting original research, and, therefore, that he is able occasionally to produce some results of his research which have not yet been published.

2670. And do you think conversely that those persons engaged in original research derive advantages from having also to teach?—Great advantages. The necessity of going over the complete course of all that is known of any considerable province of science brings subjects before the mind of the teacher, which

unless they were so brought before his mind might never receive any attention from him at all, and the result of such subjects being brought before his mind is inevitable; that he sees something more to be found out about them, and it is very probable that he may be led to take steps to find it out.

2671. I believe that your advice has been asked with respect to the establishment of a professorship of natural philosophy at Owens College?—Yes; I have been written to on the part of the trustees, and I have also had much correspondence with Dr. Joule upon the subject.

2672. What was the particular point upon which your advice was requested?—The arrangement of the duties of a professor or professors of natural philosophy, and the question, “Is it advisable to have two professors, or is it advisable to have one professor and an assistant?” and again another question, “Is it advisable to give a part of the subject commonly belonging to the province of natural philosophy to the professor of mathematics?”

2673. Is the advice which you gave in the form of a document?—No, it was merely by private letters.

2674. I believe your advice has been that those professors should not be permitted to lecture to such an extent as to make it impossible for them to devote a good deal of their time to experimental research?—Yes, I have urged that very strongly upon the trustees, and they are thoroughly convinced of the rightness of that advice, and I myself have felt fortified in it by a letter which I have received from Dr. Joule. Dr. Joule maintains that a professor cannot enter with spirit into investigations, and cannot take the position proper for a professor in such an institution as Owens College, unless he is largely occupied in original research, and from information which Dr. Joule gave me I perceive that it was absolutely impossible for the professor of natural philosophy in Owens College, with the duties hitherto laid upon him, to give much time or energy to original research.

2675. Have those professorships been established to which we are now referring?—I understand that there are two professorships now established; but there has been very great difficulty, in consequence of the insufficiency of the funds, to establish two professorships on such a scale and with such incomes to the professors as the trustees would desire.

2676. Do you think that it is essential that all professorships should have a certain endowment in addition to what could be obtained from fees?—Most desirable.

2677. Is that the case at your university?—Yes.

2678. What is your practice at Glasgow with reference to the examinations; are there compulsory examinations of all students at certain specified times?—There are no compulsory examinations of all the students, except those who are candidates for the degrees in the different faculties.

2679. Are there no preliminary examinations during the time they are going through their courses of instruction?—There are certain preliminary examinations which qualify the students for admission to the senior classes, instead of entering in the junior classes; but the custom of each of the professors is to examine in the subjects of his teaching daily or weekly during the whole session. Each teacher examines, whether *vivâ voce* or in writing, and generally both *vivâ voce* and in writing, at certain regular periods, generally speaking giving a *vivâ voce* examination every day. The examination in writing is conducted in most of the classes at certain regular intervals. In my own class I have an examination of the whole class in writing every week; I find that that gives more effective drilling to the students than any examination at rarer intervals allows of; it frees a large number of hours from the occupation of continual *vivâ voce* examination, and leaves them available for lectures or experimental illustrations.

2680. (Dr. Miller.) Does not a written examination occupy more time on the part of the professor than a *vivâ voce* examination?—It occupies a great



Sir W.  
Thomson,  
F.R.S.

8 July 1870.

deal of time on the part of my assistant, who examines the answers and marks them, and that is precisely one of the points with regard to which it appears to me absolutely necessary for the efficiency of the teaching and for the position of the professors in respect to the advancement of science, that there should be ample assistance, that there should be a sufficient number of assistants of the tutorial class capable of performing such work very accurately and safely. If I had not the benefit of an official assistant and of the other assistants whom I employ myself, it would be absolutely impossible for me to go through the amount of drilling of the students that I consider useful for them; and were I to do as much as I could towards that myself, I should have absolutely no time left for experimental investigation, or for anything in the way of preparation.

2681. (*Chairman.*) Is the staff of assistants that is now provided adequate for the work?—By no means. I have one official assistant, and his salary I supplement by a considerable addition. I employ besides, at the present time, three other assistants constantly, and occasional assistants for special experimental investigations.

2682. Does the grant of a degree depend exclusively on the final examination, or are the reports of the professors taken into account in granting degrees?—The reports of the professors are taken into account as furnishing certificates without which the degree cannot be given, but the additional test of passing a satisfactory examination for the degree is conducted independently of the professors' reports.

2683. Do you think that great dependence can be placed upon the answers to written papers without some *visà voce* examination in addition?—I think an examination well conducted does not require to be supplemented by a *visà voce* examination, but I think a *visà voce* examination is of very great importance in connexion with teaching: not so much in connexion with testing, but with that which is the chief object of a university, namely, teaching.

2684. How do your students in general come up prepared; have they received a sufficient amount of preliminary training to take advantage of the instruction which is afforded to them in the university?—There is very great room for improvement in that respect. Some students come up to the University of Glasgow very well prepared indeed, both in respect of general culture and in respect of a special knowledge of the elements of science, but the number of such students is a very small minority. The greater proportion of our students come up with very insufficient classical and general education, and almost entirely ignorant of mathematics.

2685. Then the university has to supply them with instruction in these elementary branches?—It is quite necessary in the present state of things, but it is very much desired on the part of the university that it should be relieved of the duty of teaching the merest elements, whether of classical learning or of mathematics, and until it is relieved of that duty by a more perfect general education of those who are to attend at the university, it will be necessary that the university should supplement the deficiencies which it finds among those who present themselves at entrance. It would be impracticable to reject by a preliminary entrance examination all those who come up insufficiently educated. Great harm would be done in the present state of education in this country, as many boys and young men would be sent back from the university to places where they could not possibly supply the deficiency, and their career would be stopped from the very beginning. Many of those young persons when they have become a year or two older become first-rate students, and show great ability in the several departments which they afterwards enter in the university.

2686. Are any steps being taken now in Scotland to improve school education?—Great interest was taken by the university in the education measure, and a deputation was appointed more than a year ago

to confer with members of the Government and members of Parliament on the subject of the Scotch education bill of last year; the chief matter committed to that deputation being to endeavour to secure a fair degree of favour to the higher branches in the national schools. The demand made by this deputation was that the national schools should not be confined to reading, writing, and arithmetic, but that where circumstances seemed suitable the elements of classics, the elements of geography and astronomy, and natural science generally, and of mathematics, and of physics, should be taught in the Government national schools.

2687. Are there schools in Scotland corresponding to what we call in England endowed grammar schools?—I am not able to answer that question.

2688. Can you give us your opinion as to the duty of the State in affording aid for the teaching of science?—I have very strong opinions upon that subject, and I am afraid I could scarcely state them, because they may be thought too strong. I consider that the wise liberality shown by the late Government in offering a large sum of money towards the cost of the new buildings of Glasgow University, on condition that an equal sum should be given by voluntary subscription, is an example to all succeeding governments of the kind of duty that they owe in managing the affairs of the nation.

2689. What was the amount of the Government vote?—120,000*l*.

2690. Was there any difficulty in raising an equivalent sum from private sources?—The sum raised from private sources has considerably exceeded that already.

2691. Raised chiefly locally at Glasgow?—Largely in Glasgow and the west of Scotland; I may say chiefly, I think, in Glasgow and the west of Scotland.

2692. May I ask whether that sum was raised mainly in a few large contributions, or was there a large number of contributors?—There was a considerable number of large contributions of from 1,000*l*. to 5,000*l*. each, but there were a very large number of sums ranging downwards to quite small subscriptions, subscriptions of 1*l*. or 2*l*. received by many collectors and thrown into the general fund.

2693. Have you ever considered the question whether a scientific consulting committee with which the Government might advise would be of great advantage?—I think it would be of great advantage, for two reasons. One reason of immediate practical use, to guard the Government against being deceived by unwise advisers, or by persons who may have private interests to promote by advising the Government wrongly on scientific matters: but chiefly I should say to guard the Government against unwise advisers, and to put a stopper upon expenditure of large sums upon experiments which can lead to no good results. But the principal part of the functions of such a committee are even of a more important character in the prospect of Governments in future seeing it a part of their duty to carry out and promote scientific objects, as I believe now it is felt to be the duty of the Government to do. There are many investigations which can only be done by the nation as a whole; and viewing the Government in one sense as acting for the nation, as it were a committee of the whole nation, there are very many investigations not merely of importance with reference to promoting the material prosperity of the nation, but valuable to the nation as promoting scientific discoveries, in which the whole nation takes a pleasure, and from which the whole nation derives as great benefit as anything material can possibly produce. Investigations for which a large expenditure of money is necessary, and which must be continued through long periods of years, cannot be undertaken by private individuals. Generally speaking, I believe that if the Government is well advised in respect to science, it will be for the good of the nation that the Government should make it part of its functions to promote experimental investigations in science.



2694. Have you formed any opinion as to the constitution of such a committee as we have been referring to; how the members of it should be selected?—I have no other opinion than that the men whose advice may be considered as most valuable and useful to the Government ought to be asked, quite independently of their connexion with any institution, whether under the Government or in the universities, or in connexion with any public or private body in the country.

2695. You would contemplate that committee being formed by the Government itself, and not that the universities or the scientific societies should have the right of nomination?—Certainly by the Government; but aided by recommendations from the Universities and scientific societies, and from this proposed consulting committee after its first constitution.

2696. And that they should take the best means in their power of selecting the persons best qualified to give them advice?—Yes.

2697. Would you propose that this committee should be consulted by the Government with respect to scientific education?—Yes, certainly.

2698. (*Dr. Sharpey.*) Of course the Commission are well aware of what you yourself have done towards the advancement of science, but might I ask whether in your laboratory you have a class of working students?—Yes.

2699. Who can enter the laboratory as they like?—Yes, a class that originated gradually by natural selection.

2700. Not confined to those attending the lectures?—Not confined to those attending the lectures; chiefly composed of them, however, but conducted independently of the lectures.

2701. Do they pay a fee for the permission to work, and for the instruction given?—No, not hitherto.

2702. You speak of natural selection, but I suppose you also aid in the selection of those gentlemen?—Those who do the work effectively and continue to come regularly are encouraged, and those who do not do any good, or who are irregular or show no intelligence or spirit, fall off.

2703. Then the physical laboratory is open to such gentlemen as desire to receive practical instruction and to carry on research?—Yes, no applicant is ever refused a trial.

2704. And they have an opportunity, have they not, of making original inquiries?—Yes.

2705. And they are encouraged to do so?—Yes.

2706. And of course they receive your aid and guidance?—Yes.

2707. Has any result come from that?—The various investigations that I have carried on have been aided very materially by the voluntary assistance of laboratory students; indeed, the laboratory system which has now in some degree taken root and promises permanency in the University of Glasgow originated altogether with volunteer students, who helped me in the investigation of the results which are published in the transactions of the Royal Society under the title of "Electro-dynamic qualities of metals."

2708. And since then the practice has been going on, has it?—Yes. A few students came, and afterwards more, saying that they had heard that there were investigations to be made, and offering their assistance voluntarily, so that instead of their position being that of volunteer assistants for investigations which I wished to make, I have had a great many applicants for experimental work, and I have had to endeavour to make work for them.

2709. But you were able to make work for them, I presume?—Yes, there is no difficulty in that.

2710. So that the effect was to train those men to original inquiries?—Yes.

2711. And some of those gentlemen, after they left your laboratory, have been engaged independently since, I think, in scientific inquiries?—Yes.

2712. For instance, Dr. Everett?—Yes; Dr. Everett was not exactly a student in my laboratory, but was an official assistant to the professor of mathe-

matics, and had the advantage of my laboratory for making researches under my advice.

2713. Do you think that, on the whole, it is more advisable or less advisable to extend that system of laboratory work under a professor in a university, as a means of cultivating science and promoting it, or to establish some general institution in which there should be laboratories provided by the state, or in any other way, to which people should be invited to come and work?—The object you mentioned last is no doubt a very important object, but I see at present more immediate advantage to be gained from the proposed laboratories in connexion with the universities, and the various other general schools.

2714. Institutions where teaching is going on as well as original research?—Yes.

2715. And all that, I presume, would benefit the students generally, as well as those who are actually engaged in those researches; the fact that such researches were going on would render the others more active in the pursuit of science?—No doubt it would exercise a very beneficial influence upon the *esprit de corps*. It would also influence the general feelings both of professors and students in connexion with science by keeping them impressed with the conviction that there are branches of human knowledge in which absolute truth is to be found by investigations specially directed to the discovery of truth.

2716. With reference to any application of public money for the promotion of original inquiry in science, how do you think that that could be most advantageously bestowed? By grants for the prosecution of special subjects, such as might be recommended by a scientific consulting committee, and also to some degree by establishing physical and chemical laboratories independently of educational establishments?—The second object which you mentioned seems to me of very great importance, if only to promote the detection of fraud. Chemical laboratories for testing articles offered for sale ought to be founded in every chief town, so that no part of the town or country can be in a position where it may not be easy without expense to a purchaser to detect fraud, and to bring the persons perpetrating the fraud to punishment.

2717. That of course has reference more to the practical use and application of science?—Yes, and those same laboratories would in some degree serve for original research.

2718. Then in the case of individuals carrying on scientific researches in laboratories of their own, by private arrangements altogether, receiving Government aid, it would be through that committee which you have mentioned, I presume, that you contemplate that such aid would be distributed?—Yes.

2719. Do you think that were a great physical and chemical laboratory established, and open under certain regulations to competent inquirers, that would induce men to come forward who otherwise would not, to undertake original inquiries themselves?—I think it would. I think that the fact that so many men have come forward under very great difficulties to make investigations in science, as, for example, in astronomy, promises that many men will be found to make investigations of other kinds which could only be carried on by the aid of instruments and suitable buildings, suitably situated for the purpose.

2720. But that implies, does it not, an original impulse in individuals towards such research?—Yes.

2721. Then the institutions which you contemplate would afford them an opportunity of fulfilling that desire?—Yes.

2722. Do you think that in the case of a laboratory such as your own, and of young men working there, it would be desirable to extend the aid of public money in furthering researches there?—Very desirable indeed, and it is quite necessary to ensure its being continued permanently in a vigorous way.

2723. You know that at present a moderate sum is placed by Parliament at the disposal of the Royal Society, and you are quite familiar, I presume, with the way in which that is administered?—Yes.

Sir W.  
Thomson,  
F.R.S.

5 July 1870.



Sr W.  
Thomson,  
F.R.S.

8 July 1870.

2724. Do you think that a body constituted on the principle of what is called the Government grant Committee, in which the Council of the Royal Society is included, either as it now is, or with certain extensions, perhaps ensuring the representation of various other scientific societies upon it, would be a good consulting body for the Government?—The very best. And I think that such funds as the Government grant Committee has at present to dispose of might be even more advantageously disposed of if the circumstance of such a fund existing were more generally known. I believe that a much larger sum than is at present at the disposal of the Government grant Committee, would be used with very great advantage to the nation if the circumstances were generally known. If there were a public committee whose special business was the administration of that fund, publishing an annual or quarterly report of all that is done, with that report universally offered to the public, I believe that a very much larger sum than is at present granted would be quite necessary, but you would find that it would be spent with immense advantage to the nation, and that the nation would save or gain millions for every 1,000*l.* that would be spent in that way.

2725. Would you contemplate that the Government should consult such a body as that with regard to the establishment of physical or chemical laboratories for research?—Yes, I think that such a body would be the best scientific adviser that the Government could have.

2726. Does the University of Glasgow give any instruction to the artizan class?—Not at present, I believe. I consider that it is very important indeed that the University of Glasgow should give instruction to all, to the artizan class, and to ladies, as well as to the regular students as at present; but the effective teaching power of the university must be multiplied considerably before that can be done. In the University of Edinburgh and at other places lectures to ladies have recently been instituted. No doubt that is a very proper object for a university, but I feel that in the University of Glasgow the professors are generally speaking at present overloaded with work; and to undertake such an additional labour as that, would incapacitate them for the due performance of the duties which they at present have. This does not apply to all the professorships, and some of the professors in the University of Glasgow have, I believe with advantage to the community, given additional courses of lectures; but I feel that it is quite necessary in my own department that there should be additional professors and lecturers to provide properly for popular lectures to all classes.

2727. That would require the extension of the staff or a staff of assistants, would it not?—Yes, certainly, a large extension.

2728. Could not useful instruction be given to artizans in a great industrial district like Glasgow by evening classes?—Decidedly.

2729. Do you contemplate that those should be lectures alone, or actually courses of real instruction?—Courses of real instruction, lectures with at least one examination for every week of lectures.

2730. And with practical laboratory work probably?—Yes, that could be had also. There need not be any distinction. The present laboratory system, if it could be once permanently established, is practically available for all comers. Artizans at all events would certainly not be excluded. There is no call as yet for a ladies' laboratory.

2731. The artizans would naturally be able to attend chiefly in the evening when their ordinary work is over?—Yes, but I feel it quite necessary that there should be an additional professor of natural philosophy, whether an independent professor, or an assistant of sufficient standing and sufficiently well remunerated to lecture independently as a professor, besides a considerable tutorial staff.

2732. Of course such an assistant is almost abso-

lutely necessary in the case of those weekly written examinations which you spoke of, to look over the answers?—Quite necessary for a professor who ought to be preparing his lectures to elucidate some higher points of science, or making investigations in science, or writing out results. It is a most useless and pernicious occupation of his time to be obliged to go through the continual labour of examining and marking the answers to examination questions, which is a most laborious duty.

2733. The professors in Glasgow, besides receiving the fees of their pupils, have for the most part a salary, have they not?—Yes.

2734. Have they a residence also?—Yes, all the professorships instituted before 1815 have houses attached to the office. Successive governments have since about the year 1815 instituted a number of new professorships which have been insufficiently endowed and not provided with houses at all. Very great difficulty and confusion was thereby introduced. One lawsuit, and a long succession of *quasi* hostilities between the two classes of professors followed upon that injudicious mode of action. At last it was happily settled by the recent Act putting all professorships on one footing, so far as regards their position and rights in the senate of the University. But there still remains the great defect of very insufficient endowments; for instance, in the case of the professorship of natural history, the first of the former class of "Regius professorships"; the professorship of Engineering; the professorship of English literature; and several other recently appointed professorships. The want of residences for all professorships instituted since the commencement of the old contest between the Government and the University is in respect to nearly all of these professorships a very injurious defect. We who have residences can appreciate the greatness of this defect, from our feeling of the immense benefit that we possess in having our houses in the neighbourhood of our work.

2735. So that in the case of some of the professors there is an inadequacy of salary, independent of the fees, and a want of residence also?—Yes.

2736. As to those who are in a different position, such, for example, as the professor of anatomy and some other professors, their appointment is of considerable value, is it not, independently of the fees altogether?—It is very much the same as the other older professorships.

2737. As your own professorship, for instance?—Yes.

2738. The salary is something near 300*l.* a year, is it not?—About that.

2739. Besides the residence?—Yes, besides the residence.

2740. So that that is an inducement for competent men to apply for the chairs?—Yes.

2741. Do you think that that is a judicious mode of recompensing a professor, that he should have so much certain, and the rest to depend upon his success?—Yes. Perhaps the worst defect in our present university emoluments is, the provision for the professor of natural history, and it seems a sort of retribution, that having been the first professorship that was instituted by the Crown without the concurrence of the university (the professor having been sent down to defy the university, and to take a position in the faculty), it should be now so inadequately provided for. The Court of Session awarded that the Crown had no right to send down a professor to take that position in the faculty; and so there was an armistice, as it were, till the recent Act passed, but there was a continual threatening of appeal to the House of Lords. That state of things continued until the recent Act. During the continuance of that state of things a great many new professorships were instituted; and the chairs were filled subject to the same doubt, and their occupants put in the same unpleasant position. The professorship of natural history is the most insufficiently endowed perhaps of all the professorships in the university. The pro-



fessor of natural history ought, for convenience and advantage with respect to his work, to have a house in the college.

2742. That chair includes geology and zoology, does it not?—Yes.

2743. Would you think it advantageous to make them independent chairs, supposing a sufficient salary were provided?—Very advantageous, certainly.

2744. (*Dr. Miller.*) Did I understand you to say that there are any Regius professorships under the present constitution in Glasgow?—There are under the present constitution a large number of professorships to which the Crown is the patron.

2745. Are those what are called Regius professorships?—No. The “Regius professorships” were those whose incumbents were not members of the faculty, and had not houses. The professors in chairs established prior to 1815 had all seats in the faculty and houses in the college. That was the distinction.

2746. Does that distinction exist at the present time?—No longer.

2747. So that there are no Regius professorships now?—No. Since the institution of the professorship of natural history the Crown has held the patronage of it and all subsequently instituted professorships. The Regius professor had only seats in the senate and not in the faculty, the faculty being the body that have the college funds under their management. With regard to the professorships founded before that time, the Crown was the patron for several, but the professors had seats in the faculty, and were considered college professors on the same footing as all the others; but the question of patronage is one thing, and the question of the privileges of the professors was another.

2748. Does the Crown retain the power of nominating?—It retains the patronage for all chairs for which it originally had the patronage.

2749. What is the mode of election with respect to the other professors?—That is now done by the University Court. It was formerly vested in the faculty.

2750. Is that entirely independent of the state?—Yes, entirely independent of the state. There is no nominee of the state in the University Court except the principal of the University. The court consists of the chancellor, the principal, and representatives of the university council, of the senate, and of the students.

2751. Are there any duties with regard to the number of lectures which are to be given by each professor; is there any fixed number of lectures given?—Yes, the hours of meeting, and the number of lectures, is fixed generally by regulation of the senate for each professorship.

2752. In your own case is yours a Regius chair?—Mine is one of the old chairs. It was never called a Regius chair. The patronage was never vested in the Crown. It was vested in the faculty until the recent Act. Now it is vested in the University Court.

2753. May I ask how many lectures it is expected that you, as a professor in the university, should give?—There are 10 meetings of my class weekly.

2754. Are you bound by the terms of your appointment to give a certain number of lectures?—No. It does not depend upon my own option, it depends upon the rules of the senate, which have been altered from time to time. The present rule is 10 meetings of the class weekly. One of them I optionally assign to a written examination, and the other nine are devoted chiefly to lecturing, but with the lecturing I commonly mix *viva voce* examination.

2755. As I understand you, the professors now, in addition to certain salaries, have residences allotted to them in nearly every case?—Yes.

2756. In quite every case?—All the professorships instituted previously to the professorship of natural history.

2757. That is the only professor at present who has no residence?—The professorship of natural history, and all the professorships instituted since the profes-

sorship of natural history are, as yet, not provided with residences.

2758. Is there not a pension or retiring allowance attached to certain of the chairs?—All the chairs.

2759. Is there any fixed term of occupancy upon which that is dependent?—Yes. The full retiring allowance of two thirds can only be obtained after 30 years occupancy. After 20 years occupancy a retiring allowance of one half may be obtained, and between 20 and 30 years a graduated amount of the retiring allowance. A condition of the retiring allowance which appears to me most pernicious is, that the professor is not entitled to a retiring allowance until the University Court votes that he is incapacitated from performing his duties.

2760. You have thrown your laboratory open, I understand, to all deserving students; do you make them submit to any matriculation, or first examination, as a condition to their entering?—No.

2761. So that anyone who presents himself would be allowed to try his hand?—Yes.

2762. Are they students who had been mustered in your own class previously?—I would not refuse anyone that would apply; in fact, I have never refused anyone; generally those who apply either are students or have been students, or are about to be students, but I do not make that at all a condition.

2763. About how many can you accommodate in the laboratory at present at your disposal?—I have had as many as 30 applicants at the commencement of the session, and although there is not proper accommodation for so many, yet, if there were 30 effective hands and heads there would be certainly work for them all, and space for them all to prosecute their work with some advantage, even in the old college.

2764. Does that bear any large proportion to the students who are attending your lectures?—From a quarter to one third, but I have not often had more than one half that number who have continued working very effectively during the session; from 15 to 20 is about the number who work, all of them with more or less effect, during the session.

2765. Is there any allowance from the Crown towards the expenses of the laboratory?—Only 100*l.* a year, and that was given more for the experimental illustrations of the lectures than with a view to promoting laboratory work, so that in fact the laboratory may be said to be wholly unprovided for except in respect to buildings, and such of the lecture illustration apparatus as is available for laboratory work.

2766. Then I understand you have an allowance of 100*l.* a year towards the assistant, and an additional allowance of 100*l.* for apparatus?—Yes.

2767. And does that bear any considerable proportion to the expenses of maintaining such a laboratory?—A very small proportion indeed.

2768. Could you say about what the average expense of such a laboratory may be under your own management?—It is difficult to answer that question, because so much depends upon the paid assistance. The mere laboratory expenses for the students' work in the laboratory, for material and instruments, I believe need not go beyond 100*l.* a year, not much above it, at all events. I find that 100*l.* a year generally is more than is used in materials and repairs and constructions that can scarcely be called permanent apparatus, but that is partly for illustrating the lectures. I should say that what I have found necessary for students' work that might be there conducted might come within 100*l.* a year; but then whole classes of research that I have never been able to enter upon could not be entered upon without a larger expenditure, not at all to be brought within such a limit as that:—classes of research requiring special apparatus, such as spectrum analysis, and then again accurate measurements involving very accurate measuring instruments; the procuring of such instruments for the laboratory would involve an expense which could not with any good effect be kept within such a sum as 100*l.* a year; but what I have found even more expensive than the materials is the assistance. I find

Sir W.  
Thomson,  
F.R.S.

8 July 1870.



Sir W.  
Thomson,  
F.R.S.

8 July 1870.

very great advantage in the occasional assistance that I have obtained from able students. I have found that able students who feel a proper capacity for experimental investigation, and persevering interest in the subject, have been induced, or, rather, I should say, enabled, by small payments, to give their assistance, partly in conducting fresh experimental investigation and partly in directing the work of others. It is quite impossible for one man to sufficiently direct the work of 15 or 20 workers, whether intelligent or non-intelligent, because there are two opposite kinds of difficulties. To direct non-intelligent workers involves considerable attention, and perhaps the result may not be satisfactory; but to do full justice to intelligent workers requires almost complete co-operation with them in investigation. By those means I have found very considerable additional expense where assistance has been necessary to satisfy myself at all with the progress of the daily work in the laboratory.

2769. Under the head of "Glasgow University" in the civil service estimates I observe there is 21*l.* allowed to the professor of natural philosophy, and there is also 100*l.* for an assistant; is that the whole of the endowment?—That is the whole; 21*l.* is part of the old endowment of the professorship, and 100*l.* was granted for an assistant under the recent Act.

2770. That is consolidated upon the revenues of the college, is it not?—Yes.

2771. And also the salary of the professor, is not that a grant directly from the Crown?—Yes, both the 100*l.* and the 21*l.* are granted directly by the Crown.

2772. And your own fixed salary is derived from the university?—Yes, except 21*l.* The whole of the assistant's salary and the 21*l.* of my salary comes directly from the Crown, and I sign a receipt for it to the Queen's Remembrancer. When I was asked what assistance was given to the physical department, I mentioned 100*l.* for apparatus; that has certainly under the recent Act been taken from the college revenues.

2773. (*Dr. Sharpey.*) With reference to the students of Professor Rankine's class of engineering, in what state of preparation do they usually go to his class as to their previous knowledge of mining and previous knowledge of physical science?—They may have very little when they first enter that class, but before they can obtain a diploma of engineering it is necessary that they should have attended mathematical classes to a certain degree, or else have proved themselves efficient by examination, and also that they should attend the natural philosophy class for at least one session, and classes of chemistry and geology; and proved their proficiency in each subject.

2774. Is that a condition of obtaining a diploma?—Yes.

2775. But he does not lecture systematically on physical science or mathematics, does he?—No.

2776. It is entirely the application?—Yes.

2777. (*Sir J. Lubbock.*) What is the number of pupils that you think can be most profitably handled by each professor?—I do not know any superior limit.

2778. In the case of our great public schools, what number of pupils do you think it would be desirable to have for each tutor?—That depends altogether upon the system upon which the teaching is conducted. I cannot answer the question as to how many could be advantageously drilled by one tutor, so much depends upon the subject, and the particular plan of drilling that is followed.

2779. Assuming that there are 900 boys at Eton, what number of masters do you think should be engaged in tuition there?—I can scarcely answer the question.

2780. Do you think that it would be desirable at the great public schools to have periodical examinations at such short intervals as those you have been alluding to in your previous evidence?—Yes, provided the examinations are conducted by the teachers in close connexion with the teaching.

2781. At what age do you think it desirable that the teaching of elementary science in our primary schools should be commenced; in fact, how young do you think a child could, with any profit, commence instruction in elementary science?—I think that at 12 or 14 the commencement of teaching in some branches of science would be very advantageous. I scarcely think before 12; but I think that boys of good intelligence might be very advantageously introduced to much of natural science at 12.

2782. Then I am afraid that would almost exclude natural science from the primary schools of the country, because we can hardly hope to keep children there after 14?—No; I scarcely like to adhere to any such answer, except in respect to the more abstract branches. For instance, higher mathematics and dynamics may be very advantageously commenced at 12, but I doubt whether there can be much advantage in commencing such subjects before 12. But there is a great deal of general knowledge in natural history, and geography, and chemistry, which I think could be imparted very advantageously indeed to boys of considerably younger age than 12.

2783. (*Mr. Samuelson.*) You spoke of a grant of 120,000*l.* from the Government to the University of Glasgow, for building; did you find that upon that grant being made, there was any slackening, or the reverse, of subscriptions from the neighbourhood?—Very much the reverse; it gave an immense impulse to the private subscriptions.

2784. Would you conclude that the same result would probably follow in other similar cases?—Yes.

2785. You are aware that a great effort is now being made to extend the sphere of activity of Owens College?—Yes.

2786. Do you think that the authorities of that college would be justified in expecting, and that the Government would be justified in granting, some assistance to that institution similar to that which has been obtained by the University of Glasgow?—I cannot conceive any justification whatever to the Government for not granting such assistance.

2787. You think that the Government would not be justified in refusing it?—Yes, and not merely because of the precedent of Glasgow University, but on account of the usefulness of the thing itself to the country, and on account of the Government being the trustee for the devotion of the money collected by taxes to purposes useful to the taxpayers. If the grant to Glasgow were right, withholding a grant to Owens College, or similar institutions, would obviously be wrong.

2788. Are you able to state what proportion the amount received from fees at Glasgow bears to the amount received from the state and the university endowments. I am speaking now with reference to the emoluments of the professors?—I should think that more on the whole is received in fees than from endowments, if the value of the buildings were set aside, but if the value of the buildings were taken into account, then I should say that the fees fall considerably short of half the resources of the university.

2789. But so far as the income of the professors is concerned?—Rather more from fees than from endowments, on the average, perhaps.

2790. But how would it be if you were to value the residences as a portion of the emoluments?—Then it comes to be more nearly equal, in many cases just about equal; in only a few cases are the fees more than the endowments together with the estimated value of the house.

2791. You stated that you would be glad to see instruction given to artisans at the University of Glasgow, but you are probably aware that very few of our universities are placed in localities like Glasgow, in which large masses of artisans are collected together?—Yes.

2792. Would you consider that where no university existed in such large centres it would be desirable for the Government to encourage the creation of schools of science?—Decidedly, especially for artisans.



2793. Would you in those schools of science include technical classes?—I do not know what a technical class is exactly. I think there is a great deal of mistaken desire to promote what is called technical education. For instance, a technical chair of chemistry in Glasgow has been offered, but under conditions which have not as yet led to its acceptance on the part of the Andersonian Institution there. I have a general feeling that a chair of technical chemistry has nothing to teach that is not better learnt in a manufactory. There is only one chemistry, and that is true chemistry; and it is much more desirable, therefore, for those who are going into a chemical manufactory to know true chemistry than that which would be of the most trivial value to them, namely, to have attended courses of lectures upon the processes of calico printing and bleaching, and the manufacture of colours, elaborately described with illustrations which the students are better able to see in the workshop. I see no benefit in anything that I know from the so-called technical classes, except engineering, so far as that may be considered to come under that category. There is a great deal of strict science and the application of scientific principles that can be taught successfully by lectures and instruction to classes of students in the department of engineering; but I do not know anything else in the way of what could in any respect be called technical instruction which could, in my opinion, be advantageously conducted by special lectures and teaching.

2794. Would you in all such cases expect that the special instruction should be received in the workshop?—That which is of the greatest importance is a thorough knowledge of the scientific principles of the work to be done, before entering the workshop; there every pupil or apprentice, on beginning, must learn what to do, and further, what variations in the process are necessary in consequence of new inventions and improvements introduced from year to year.

2795. Where would you learn that?—First in the workshop, for the chances are that the professors would be teaching something in the technical chair that people in the workshop are not using, and further, what they would laugh at if they heard that it was being taught as the way to do a thing which they knew so much better how to do otherwise.

2796. (*Dr. Sharpey.*) But in addition to engineering, do not you think that metallurgy is also a subject which might be largely taught in a school independently of actual work?—The chemistry of metals of course might be taught.

2797. Such a subject, for instance, as practical assaying?—Yes, the chemical analysis of any given substance.

2798. Take, for instance, the case of a man who is going abroad to become an assayer, say in Australia; might he not receive in a laboratory in this country quite sufficient training to enable him to find no difficulty when he entered upon his work?—Certainly, but it would be very desirable that he should also have been an apprentice or a pupil in an assay office, either of the mint or of private firms, to see the way that they conduct their business.

2799. You are aware that the late Professor Graham, and also Professor Miller, had in their own laboratories the duty of controlling the mint assays, and that young men were trained to do that work?—Yes.

2800. That might therefore be accomplished?—Yes, certainly; and there must be more or less of teaching in every manufacture. Every beginner must be taught what to do, but it is in the factory that he is best taught anything that is known as technical chemistry.

2801. Of course you have seen much of that in Glasgow, in print works and chemical works?—Yes.

2802. Is there a technical class for artisans at what is called the Andersonian University?—Not technical. There are several elementary scientific classes for artisans.

2803. Do the professors there teach the principles of science in the classes for artisans, or do they teach

merely its applications?—I believe that they teach the principles.

2804. Has that been attended with good results?—Very good results. I do not believe that artisans would come to the Andersonian Institution to learn their trades, but they do come with great avidity to learn the principles of science, and they are very thankful for the benefit they receive.

2805. The late Mr. Graham once gave lectures in chemistry to artisans in the Andersonian University, did he not?—Yes.

2806. But the workmen would not regard any attempt to teach them their business as likely to be successful?—No, I am sure they would not.

2807. (*Professor Huxley.*) Do you not think that the teaching of medicine is very much technical teaching in the sense in which that word is commonly understood, that is to say, teaching the application of branches of science to a given art?—The art is so very far removed from manufacture, that I would certainly not consider that the designation of technical education was properly applied to medical education, and further, the great mass of medical education is necessarily scientific. The technical part of it is learned in the hospitals, or learned by assistants or apprentices to medical practitioners.

2808. But still there is a great deal of instruction in the medical schools in, so to speak, the theory of the art of medicine?—Exactly so, and that is somewhat analogous to engineering and physical science.

2809. Have you the same objection to a school for teaching the applications of science to the art of navigation?—Precisely the same. If the same words are to be applied, technical navigation would mean teaching a man first to walk on the deck of a ship in a sea-way, and then, in those circumstances, to perform the various acts that are to be performed. But the science of navigation includes some of the highest branches of abstract science, geometry, astronomy, and dynamics; I look upon navigation as quite analogous to engineering or to medicine. The principles of nautical astronomy ought to be well taught, the principles of magnetism ought to be well taught, and the principles of hydro-dynamics and of general dynamics unquestionably also ought to be well taught; but no part of such teaching could possibly be called technical in the sense in which I object to technical education in schools or colleges. The technical education of a sailor must be had on board a ship, and cannot be had except on board a ship.

2810. Do not you think that a person who is intended for the life of an officer of a ship may be all the better for having learned how to do a day's work and to take an observation of the sun?—Yes, but if he knows the principles he will learn how to do a day's work the first day he has it to do.

2811. Still there is a certain amount of practice required in order to do it properly?—Yes, but I think that it is only to be learned at sea. It is useless to try to learn it on land. In the first place you have not the horizon, and in the second place you have not the motion of the ship.

2812. A great many navigation schools are placed in seaport towns, are they not, where both of these desiderata are very easily obtainable?—Yes, I dare say they are, but I believe practically the best way to learn is by thorough teaching in the first years after going to sea, or perhaps in training ships for boys. The previous training that seems to me important for promoting and improving the education of naval officers, whether in the royal navy or the commercial navy, is a good elementary education, including modern languages, a good knowledge of arithmetic, a good knowledge of elementary mathematics, including spherical trigonometry, a good knowledge of the elements of physical science, and a special knowledge in practical astronomy. All that is most particularly useful to navigators, but it all belongs to general science and is more or less useful to all, whereas the technical parts of navigation come instantly in practice, except such as require skill acquired by long usage at

Sir W.  
Thomson,  
F.R.S.  
8 July 1870.



Sir W.  
Thomson,  
F.R.S.

8 July 1870.

sea. I do not think the slightest good will ever be done to naval education by technical schools in which anything but subjects of general education is taught.

2813. I entirely agree with you as to what you say with regard to the value of general training in science, but I understand you to add further that you would not think it worth while to modify the training in science of a person destined for the sea in any way differently from that of a person destined for any other occupation?—Except to make sure that he learns modern languages, spherical trigonometry, astronomy, dynamics, and magnetism.

2814. Then you would to a certain extent modify the education of a person intended for the sea in a different direction from that of a person intended for land pursuits?—Yes, just as I would for any other pupil whose profession is foreseen. Some branches of general science will be more valuable to him than others. As he could not learn all, it is better that he should learn those that would certainly be useful, and which are more important for him to learn than for others.

2815. That is *pro tanto* technical education: it is education specially gained with a view to his special calling?—Yes, that is undoubtedly beneficial, and is always very properly to be carried on in a university. I may add as an illustration that recently a lectureship has been instituted in the University of Glasgow for teaching the application of Archibald Smith's magnetic principles to the adjustment of the compass.

2816. I apprehend that you would have no objection to, but on the contrary would rather see an advantage in, a person intended for mining being taught the principles of working a mine and managing a mine, as part of his education?—It is very important, if he could be well taught it.

2817. And that would be so far technical education?—So far of course it may be called technical education.

2818. Does your objection apply to the establishment of special technical schools, as such, or to the establishment of what is called in the broad sense of the word technical chairs in a university. I apprehend from what you have told us that you have no objection to the establishment of chairs for the purpose of teaching the applications of science to a given art?—No.

2819. But you rather object to the establishment of special schools for the same purpose?—On the whole I object to the establishment of special schools, because I think that the effect is likely to be not beneficial to the pupils. I think that the scientific part of the education is likely to be of an inferior stamp, although not necessarily so; and I think that there is sometimes an injurious moral influence upon young persons being all collected in a school in which they are taught to consider that they are to learn simply for the purpose of making a profession of what they learn. I think it has a better moral influence to let the pupils feel that they are learning for the intrinsic value of the learning; and that they should enter a profession ultimately, and take a professional position when their school and college education is completed. There still must be in every profession much teaching of the principles, but I think that that is better done in the profession than in a technical school. For instance, I think that in the army it probably would be better to have a great proportion of the education in general colleges, and a comparatively small part or none in special military colleges, and that rather the young officers should be taken in hand and taught for a good many years, and deficiencies in their education supplied, than that they should be congregated in professional schools, and sent forth from those schools with the feeling that now their education is over.

2820. I apprehend that a good deal of your objection to technical schools, if one may so call them, would be removed if all persons studying in those schools were compelled before they entered them to pass through an examination showing that they were well acquainted with general science, and that they

had received a good general education?—Yes, that of course would remove some part, but only a small part, of the objection that I feel.

2821. Are you acquainted with the system of science examinations which have been established by the Department of Science and Art?—I cannot say that I am sufficiently well acquainted with them to express an opinion.

2822. I understand you to speak with great approbation of the Government grant committee and its present working; can you suggest any method by which that Government grant committee could be so organized as to make it a satisfactory means for the administration of larger sums of money than are now administered by it?—To make it a somewhat more comprehensive committee, possibly, but I do not know how far its constitution is comprehensive at present. I see, however, one important improvement in its mode of action, in my opinion, and that would be to make its proceedings more public; to publish regular reports, and to let the whole country know what grants are made.

2823. Have there not been returns to Parliament of the applications of the fund from time to time?—No doubt. I do not feel that there is anything defective at all in the present system, but I do not think, for instance, that one in ten of the scientific investigators know that there is a possibility of getting any money, and where to apply for it.

2824. Do you think it would be an improvement if the constitution of that body were so far changed that instead of its being to a considerable degree either members of the Council of the Royal Society, or else the nominees of that body, there were delegates added from other independent bodies in Scotland and Ireland?—I think so, both from the scientific societies and the universities.

2825. I judge from what you state that you would like to see it converted into a sort of scientific parliament, with the power of voting grants for scientific purposes?—"Parliament," perhaps, is rather too strong a word. A scientific advising body, but with the full power of voting grants, certainly.

2826. As a matter of fact, you would wish that, as at present, within the limits of the sum annually at the disposal of the committee by Parliament, they should be independent of any control outside?—Yes, that expresses my idea; that the same committee might add to those functions that of voting money, or advising Government with respect to voting money; that there should be a definite sum put at its disposal; and besides that they ought to have the duty of advising the Government as to other objects for which their ordinary funds are inadequate, or objects that are not directly the subject for a money grant from the committee. If the Government should wake up, for instance, to the reform of the system of weights and measures, the scientific committee would usefully advise it in such matters as that, although not involving the expenditure of money.

2827. Do you think that a body so numerous, and of so very diversified a composition, as the Government grant committee could well advise the Government; or do you not think that it might be better to ask such a body as that to nominate a committee of persons to decide upon each question submitted to it by Government?—Probably the best way of working a large body, such as has been suggested, would be to have acting sub-committees for various purposes; for instance, a grant sub-committee, and an advising sub-committee.

2828. I gather from what you have stated that it is your opinion that in all scientific teaching there are three different methods of operation to be regarded. In the first place, lectures by competent professors; in the second place, tutorial work; and in the third place, actual acquaintance with the facts at first hand in the laboratory?—Yes.

2829. Would you add anything else to those three branches of instruction that I have mentioned, or does that complete the whole?—I think that the



accompaniments of that, such as proper drill and private reading, comprehend all that is necessary.

2830. That would come under the tutorial head, I suppose?—Yes, tutorial and professorial.

2831. I imagine that in most of our teaching bodies, at present, the second and third heads, that is, tutorial work and laboratory work, are very insufficiently provided for?—Very insufficiently indeed.

2832. I presume that I may have the advantage of concurring with you in opinion when I say that no scientific teaching can be thorough, or do its work well, unless all those three modes are thoroughly well provided for?—No, certainly not.

2833. You are aware that it is very much the practice in many of the continental universities to make a candidate for a degree do a piece of work or go through an investigation?—Yes.

2834. Do you not think that that is a practice which might with advantage be introduced into our English universities?—No, I think not.

2835. May I ask your reasons?—I think it would generally be very unsuccessful. It would be a perfunctory operation in most cases, and done as a form because it must be done, amounting merely to a thesis, or a compilation from the courses, which is not proposed to be read, and certainly would do no good to any reader.

2836. But I am informed that in some of the German universities, take for example Marburg, a candidate does not get his degree unless he has done something, and that a very respectable piece of work for a young man?—I think that the tests of regular examinations in connexion with teaching and the public examinations of all candidates for the degrees are very much more effective than any such prescribing of theses can possibly be.

2837. Does the University of Glasgow grant any degrees in science, say apart from the professions?—Not excepting so far as the master of arts degree is a degree in science; it is a degree in science, literature, and mental philosophy. There is no special degree in science, and no higher degree in science at present. Many proposals have been under the consideration of the university for establishing special science degrees, but no conclusion has been arrived at at present.

2838. You are aware that in the case of the London University the degrees of bachelor of science and doctor of science are both granted?—Yes.

2839. Is it your opinion that the granting of such degrees by the University of Glasgow would be advantageous?—I think, certainly, granting the degree of doctor of science would be advantageous;—a degree to be given to candidates who have already taken the degree of master of arts. I do not feel the same confidence as to the degree of bachelor of science in the peculiar circumstances of the University of Glasgow; but a proposal has been recently made, and is under the consideration of the senatus, that the diploma of engineering should be constituted into a degree, and that the holder of that degree, therefore, would become entitled to be a member of the University council, and to have a vote in the University constituency, and all the other advantages of graduates. I approve highly of that proposal, and it would certainly have almost the same effect as establishing a bachelor of science degree, though under a different name.

2840. The master of arts degree, of course, includes considerable proficiency in the natural sciences?—No, too little. It ought to include them, but there is great difficulty felt as to the question of classical education in connexion with degrees. In my opinion both Latin and Greek should be required: but the amount of books to be read and examined upon in classics for the degree of master of arts is very much too long at present; I do not say too difficult, but much too long, and occupies too much time in my opinion in special preparation. Were less time occupied in that way in classics, I think that our master of arts degree might be made to include the subjects to which you have referred; that is, if you feel satisfied with requiring

something of classics. If less time were required in particular reading for the degree examination in classics, then there would be more room for natural science, chemistry, natural history, or generally the less mathematical parts of natural science, than there is at present. We have just now undoubtedly an overloaded curriculum.

2841. Would you not be satisfied if a candidate were required to pass a bachelor of arts examination, and then that he might leave aside his literary training, and be able, if he chose, to take a special degree in science?—We have no bachelor of arts examination. I wish to reduce the necessary amount of knowledge of particular books in classics to something which may possibly correspond to that to which you refer; but, at all events, I think that very much less time should be of necessity spent in reading Greek and Latin authors, and preparing to pass an examination on particular books.

2842. (*Sir J. Kay-Shuttleworth.*) I have understood you to say that you consider that if complete instruction be given in pure science which is applicable to any forms of industry, or of practical occupations in life, the application of that pure science is best learnt in the actual industry?—Generally speaking I think so.

2843. Are you personally well acquainted with the condition of the instruction of the persons who are at the head of what are technically called the colour shops in the printing and dyeing trades of Glasgow and the neighbourhood?—I am not particularly acquainted with them.

2844. If it should be the fact that those persons are for the most part totally destitute of scientific instruction, would you think them very competent persons to take charge of the instruction of a young man in the application of pure science to the particular industry?—Certainly not. I think that it would be of very great advantage that they should all have learnt chemistry well.

2845. But in the absence of such opportunities for learning the application of pure science to industry, might not, even if it were regarded only as a temporary condition, a chair which should teach the student, after he had acquired a competent knowledge of pure science, the practical application of that science to industry, be useful not merely to the student but to the manufacturer?—I think what would be more useful to the manufacturer would be a little more chemistry, a better knowledge of the principles of chemistry.

2846. To whom?—To whatever person you refer to as having already gained a certain amount of knowledge of pure science, to whom it had been proposed to give technical instruction in the shape of lectures.

2847. Is it not an advantage to those young men that the technical professor should teach them the application, for however short a period, say of chemistry, to dyeing and to calico printing, than that they should go under ignorant men in colour shops?—I think the time that they would devote in following the lectures of technical professors would be very much more advantageously spent in following the instructions and laboratory exercises of a professor of elementary chemistry, which would give them something useful for all their lives.

2848. When they have acquired a thorough knowledge of chemistry, is not the application of that knowledge of chemistry to particular industries advantageous?—I think it is more advantageous to go to a chemical laboratory and make chemical analyses, if they have time to devote to it.

2849. Of course a person in a chemical manufactory must have a knowledge of the application of chemistry to the particular industry, but that is what you would not teach in the chemical laboratory?—I do not think that there would be very much advantage to the pupils from the professors knowing or teaching the particular way of carrying on a particular industry at a particular time. I think that for the benefit of the persons about to enter a manufacture, they should be taught as much

Sir W.  
Thomson,  
F.R.S.

8 July 1870.



Sir W.  
Thomson,  
F.R.S.

8 July 1870.

of the science of chemistry and other physical sciences as the time that can be given up to education before entering the manufactory admits of; and that the mode of managing colours, and so on, for a particular manufacture, is best learnt in the actual workshop.

2850. Taking into account such a fact as this, that the art of mining differs exceedingly in different districts, that if a young man goes into a particular district with merely scientific knowledge he learns the practical art of that district only, and does not acquire a knowledge of the practical art of other districts, and it may be by accident that he shall go into a district where practically the art of mining is very low, and is not scientific; how would you compensate for the non-application of science to the practical art of mining in that district?—By teaching him dynamics, and pneumatics, and geology, and underground heat.

2851. And leaving him to find out for himself what the practical experience of other districts had probably fully developed, if he had any opportunity of knowing what they did there?—Yes, by inquiry, and reading, and travelling to visit other districts.

2852. But would it not be better that the professor who knew what was done in every district, and knew the principles upon which the practice of each district was founded, should teach this young man before he went into the mines what were the principles so involved, and what were the best practices of mining?—If that could be done without sacrificing anything of the general knowledge of geology, and the general knowledge of natural philosophy, and mathematics, and chemistry.

2853. Take, again, the art of navigation; are there not recently introduced new modes of sailing which were not in possession of old navigators, and which a young man would not learn on board ship, but which he might have acquired if he had attended the lessons of a practical chair of navigation, which are not matters of pure science, but to a very great extent matters of practice?—Not so far as I know.

2854. There is, for example, what is commonly called line sailing and great circle sailing?—Yes, but that is the first thing that he learns in spherical trigonometry. When he learns spherical trigonometry he learns more than all the nautical professors in the world could teach him, except the currents and the prevailing winds, and the chance of meeting icebergs, and under what circumstances it is necessary or advisable to deviate from the great circle in some degree; and I cannot conceive a technical professor of navigation giving him anything very useful towards those things.

2855. But is that art very generally practised now in the mercantile marine?—So much not so that I believe that there are some navigators still who will sail along a parallel of latitude because it is easier for them to work the reckoning upon that system. I know that such has been a practice with some, although I do not know that it is a practice still.

2856. What I wish to press upon your attention is, whether a chair in which the last results of the application of science to practice could be taught would not greatly assist in the diffusion of scientific principles in connexion with our practical industries?—Not so much as the teaching of scientific knowledge. For instance, a school of telegraphy established this day would be teaching the practice of instruments that will not be used perhaps 10 years hence; but if the same time were devoted to learning thoroughly the principles of electric science and electric measurement, a person entering a telegraph office would learn in half a day the working of the different instruments, and in a few days or weeks practical skill in managing and understanding all the little points about them; and his acquaintance with the principles would enable him either to invent other instruments himself, or to appreciate other instruments, or to see how to work them when brought forward by other inventors.

2857. You would not appreciate my questions if you were not to presuppose that I had intended that the highest scientific instruction should precede the

technical instruction; but the point to which I wish to direct your attention is, whether, conceding that a high scientific instruction had been given in the present condition of things to those who had the charge of the industries of the country, it is not extremely important that its application to those arts and industries should also be taught?—In some cases, no doubt, but I can conceive very few cases in which there is much to be well done in special colleges or schools for the so-called technical departments. In the case of telegraphy there is a great deal to be learned, but it must be learnt by going out along the lines, setting up lines, and going out with the engineer to repair lines, besides the work in the offices. Upon all that work the engineer is thoroughly prepared to enter with intelligence, if he knows the general principles of science very well, and if he has learnt what is taught in the engineering professorships; for instance, drawing, and applied dynamics: but the particular technical instruction in telegraphy would be, in my opinion, quite useless, and worse than useless, were it to take any time whatever from instruction in general principles. Of course, when I say useless, I mean as compared with the more useful instruction in the workshop or the telegraph office.

2858. But for the purposes of such instruction in the workshop you would desire, would you not, that workshops should be under more enlightened managers?—Decidedly.

2859. And if possible under scientific managers?—Yes, that every workshop should become a technical school for all the young persons in it.

2860. With respect to the general instruction, for instance, in mathematics and practical mechanics, as it has been conducted in, we will say, the English universities, it is quite obvious that that instruction has produced but few inventors and few discoverers; and I would ask you whether the chief source of invention and discovery, beyond great original genius, has not been the contact of students with persons engaged in scientific research?—Yes, decidedly.

2861. And that any man like Davy or Wollaston or Faraday, who has had under him a pupil of something beyond average capacity, has almost necessarily produced an investigator?—Yes, their influence is of course very great in that direction, and most important.

2862. And on that account it is obviously of very great importance that there should be encouragement to the connexion of scientific research with the chair of teaching, under whatever conditions may be found most desirable?—Yes.

2863. (*Professor Stokes.*) The system of teaching followed at the Glasgow University is, I understand, that the professor in any branch has charge of the whole teaching in that branch, and that the tutorial staff work under him?—Yes.

2864. Do you or do you not consider that a preferable system to that in which the more ordinary teaching of the branch is carried on by tutors, each working for himself according to the system which he conceives best (and those tutors possibly competing with one another), and then the professor gives supplementary teaching in the higher parts of the branch, or those parts which require experimental illustration?—I think the system which you described last would have some great disadvantages as compared with the other. A professor ought to be able to get hold of the multitude and impart the elements of the subject, and he ought also to be able to take up the highest branches. It is rather the intermediate instruction that I think can be safely left to the tutorial working. If the tutorial working be quite independent of the professors, but a small number of students would experience the influence of the professors; and I think that the most important influence of all that a professor has is the general popular lectures;—those that are given to the greatest number, to people many of whom never can rise to the highest parts of the subject. The next most important object of a professor in my opinion is, doing all that can be



done for the higher students. I do not see how those two objects can be worked out unless the tutors and the professors, if there are more than one for the same subject, are all jointly responsible under some one head closely connected with them.

2865. You said that you are in the habit of requiring examination papers weekly to test the progress of the students; but besides that, I presume that once or oftener in the session there are papers given on the results of which the students get certain advantages?—So far the class prizes are awarded from the results of the weekly examinations. There are special examinations and special prizes for special subjects, the higher subjects chiefly.

2866. In the weekly examinations has each student a considerable time in which to answer the paper, or has he to answer it as fast as he can put pen to paper, or nearly so?—My weekly examination has only an hour available, and the questions are arranged as far as I can to render it quite possible for a student to answer them all, so that mere speed of writing ought not to tell at all upon the result.

2867. You said that you thought it would be a good thing if there were a body of scientific men to whom the Government might apply for advice, who should be appointed by the Government, or selected by the Government?—Yes.

2868. Would you have them a permanent body, with, it may be, a certain number of members going out by rotation, or in the event, suppose, of a change of Government, would you throw over the whole body?—A non-political body, I think, would be necessary for good action.

The witness withdrew.

Adjourned to Tuesday next, at 11 o'clock.

No. 6, Old Palace Yard, Westminster, Tuesday, 12th July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

HENRY WENTWORTH ACLAND, Esq., M.D., F.R.S., examined.

2874. (*Chairman.*) I believe you are a fellow of the Royal Society?—Yes.

2875. And also a Doctor of Medicine of Oxford, and you hold honorary degrees from other universities?—Yes.

2876. You are also Regius Professor of Medicine at Oxford and Radcliffe Librarian, formerly Lee's Reader in Anatomy?—Yes.

2877. Have you held office in Oxford as professor or reader for many years?—Yes, for 25. I became reader in anatomy in the year 1845.

2878. Have you for a long time paid attention to the connexion of physical science with education?—Yes, I was led to do so from accidental circumstances very early in life.

2879. When did you begin to take steps to extend the means of study in the departments of biology?—It was in the year 1845 at the time that I was appointed to the readership in anatomy. I was a student at Edinburgh, and unexpectedly, being a pupil of John Goodsir's at the moment, was called upon to undertake to teach the department of physiology in Oxford. Upon so undertaking it, I had seriously to consider what were the means of carrying on such a work, and what kind of duties I had undertaken. As a pupil of Goodsir's I had been working with him

2869. (*Dr. Miller.*) Why is it in your judgment that the universities in Scotland have succeeded in obtaining those large subventions, whilst that is not the case in this country; upon what principle do you consider that there is any difference?—I cannot profess to explain the principle. I saw the answer which was given to a deputation from Owens College on the part of the present Government, to the effect that Parliament did not generally grant assistance except to the universities, and to the capital cities of London, Edinburgh, and Dublin. That seems to have been the reason on which the grant was refused to Owens College, but it remains to be considered whether it is a good reason or not, or whether it can possibly be more than a temporary reason for not giving it in one particular year or on one particular application, until Parliament and governments see clearly their way to vastly enlarging the means available for higher learning among all classes of the community.

2870. (*Chairman.*) Has the grant to Glasgow led to applications from the other Scotch universities?—Not as far as I am aware.

2871. Are the other Scotch universities pretty well provided with buildings?—I would not like to speak for them all. I know, in fact, that the University of Edinburgh does not feel satisfied with its present site or buildings.

2872. (*Dr. Miller.*) Has the University of Glasgow any property of its own, independent of the buildings?—Yes.

2873. Can you state the extent of it?—I do not know the amount.

at the great undertaking in which he was engaged, namely, the construction of an extensive series illustrative of physiology, copying in fact the great collection of John Hunter, which is now in the College of Surgeons in London. Goodsir was making such a collection for Edinburgh, and upon being called upon, while still a student, to teach in Oxford, I came to the conclusion that in a national university nothing less was requisite, if it was desirable to teach biology at all in a place of that kind.

2880. What steps were taken by you?—I have stated that as regards my own speciality, namely, teaching what we then called physiology, but which now probably would more properly be called biology, the office for which I was chosen was not a university chair at all. Things at that time in Oxford were in a great confusion, as it seemed to me. For instance, the university professor of anatomy was also the professor of medicine. He did not teach, and had no means of teaching. Whatever was done in teaching anatomy and physiology in Oxford, was done not by the University but at the college of Christ Church. I became only a collegiate officer with a salary of 200*l.* a year. I was not officially recognized by the University as a teacher at all. I was specially excluded from any kind of public position which

Sir W.  
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8 July 1870.

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12 July 1870.



H. W. Acland,  
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F.R.S.  
12 July 1870.

would attach to a university officer. Still there were no means of studying either anatomy or physiology in Oxford, except at this little place at Christ Church, and, therefore, strange as it would appear to a foreigner, this college, by its funds and its officers, had to provide for the study in the University, so that it came about, as I stated just now; therefore it seemed right to endeavour to make a large collection in a college, but not in the University. The collegiate building was a very small one, and it was clear to me that if a considerable collection of biology were formed there, then the building would have to be rebuilt. I then considered that the other collections, the collection of zoology which belonged to the University at the Ashmolean Museum, and the collection of geology which was then being formed with great zeal by Dr. Buckland, were in the same condition. In fact, that it was clearly desirable to reconstruct the whole of the apparatus for scientific study, not in my own department only, but in all the departments. I find that in the year 1847, on the 12th of July, I drew up a paper which contains the origin of our present scientific institute, or museum, and which I should not mention were it not for the circumstance that that document was a request to all the friends of the University to aid in the construction of a complete apparatus for scientific teaching. It was intended by that document that all those who possessed departments where apparatus was necessary should join in this resuscitation, as we may call it. On that document I find the names of Dr. Daubeny, Philip Duncan, who was the Keeper of the Ashmolean Museum, and Mr. Robert Walker, the Reader in Experimental Philosophy, as it was called (all, I am sorry to say, dead), and the fourth name is my own as Lee's Reader in Anatomy. There is a blank at the head, which should have been filled up, for William Buckland, then Dean of Westminster, a man of the highest position at that time in the scientific world, but who resided in London, and who, when applied to, to aid us, said, "The case is so absolutely hopeless that I shall have nothing to do with the matter." The document has therefore his name unfilled, for he declined to give us any assistance, or even to lay the matter before his personal friend, the Prime Minister, Sir Robert Peel. I say that simply as a matter of history. Dr. Buckland was a personal friend of mine. But I think it due to those who, like Mr. Gresswell, Dr. Pusey, Dr. Williams, and many others (of whom you will be surprised to hear, and whom as an act of justice I name), to say that notwithstanding that the scientific veteran, with extraordinary opportunities for furthering such a scheme, felt himself unable, on account of the hopelessness of the task, to assist us, many older members of the University undeterred supported our attempt. It is owing to their exertions following upon this document which I have just drawn your attention to, that the scheme of constructing the modern scientific plant of Oxford has been able to be carried out at all. I will hand it to the Commission as a mere matter of curiosity. It is in these terms:—

"We the undersigned, being officially connected with various institutions for the advancement of natural knowledge in this University, are of opinion that the several collections contained in the Ashmolean Museum, the geological museum, and the anatomical museum in Christ Church, are deposited in rooms of inadequate dimensions and inconvenient arrangement; and that their present efficiency and future progress are by these means retarded. Believing that the future welfare of the University is intimately connected with the progress of all her institutions, the undersigned are desirous of furthering such steps as may tend to the erection of an edifice within the precincts of the university for the better display of materials illustrative of the facts and laws of the natural world. They would recommend that in connexion with such an edifice there should be lecture rooms suited to demonstrative lectures, and apartments calculated to serve the purpose of a library, and

of a place for scientific meetings, as occasion may require. They commend this matter to the earnest consideration of those who are interested in the welfare of Oxford, and they will be grateful for their opinion and advice as to future proceedings in this matter.

(Signed) CHARLES DAUBENY,  
Professor of Chemistry and Botany.  
P. B. DUNCAN,  
Keeper of the Ashmolean Museum.  
ROBERT WALKER,  
Reader in Experimental Philosophy.  
HENRY W. ACLAND,  
Lee's Reader in Anatomy."

2881. What was the next step which you took in the proceedings to provide a museum?—The next actual step that was taken was I am afraid the usual kind of laborious agitation that men who are bent upon an object in this country, which object their fellow creatures do not sympathise with, have to go through, the writing of hundreds and thousands of letters, the obtaining the services of persons more or less interested in the matter, and getting together, as we did then get together, supporters of all kinds. It is very curious, indeed, in looking over the list of those who undertook this business, to see how many in this short time are gone, and what a heterogeneous collection of persons they were. Some of them have become eminent since. For instance, the present Dean of St. Paul's, then quite a young tutor; Mr. Johnson, of the Radcliffe Observatory; Mr. Baden Powell, Mr. Donkin, and a number of other persons. We had to endeavour to carry out the plan by subscription. It was clear it would require a very large sum of money. After three or four years it seemed impossible to raise the amount. Then the gentleman who was Vice-Chancellor, Dr. Cotton, of Worcester College, on one occasion said to me that he thought he could persuade the university to vote 30,000*l.* After a year's more agitation and trouble we did get this 30,000*l.* We planted in a ploughed field the present University museum. It will save the time of the Commission if I now tell them briefly what it is. This is the elevation (*producing the same*) of the building. I have the original contract plans here. I have already stated that the original object of this scientific building was to collect together the different illustrations of science which we had in the University in our different collections. The idea was sufficiently expressed in the paper here handed in, that our intention was to provide a means of studying every department of the natural world. That paper was drawn up by me with some care, because there were many prejudices to be encountered at that time, and we had to be very careful not to say anything in this document which would offend any prejudices. The intention was to provide all the means for scientific study in every department. It has been objected by some foreign critics who have been over this building since it has been an accomplished fact, that instead of bringing our collections together, and making what they have been so kind as to describe to me as a confused mass of subjects in one building, we ought rather to have built a number of new scientific buildings in different parts of our University. That was not our plan, whether it was good or bad. We thought it very desirable that all the professors in the several departments should have a ready means of communication one with the other, and should have a ready means of comparing their collections one with the other, the geologist with the mineralogist and the anatomist, and all those with the chemist, and so forth; so that it was our intention to bring all our laboratories as it were to one point, not only for the sake of the collections, but for the sake of the interchange of ideas, and for the united work and common objects of our several teachers. At the same time we thought it desirable to have a scientific library, if possible, at the same spot. The plan shows you a large area for collections; round that given area are lecture rooms for the several departments; and,



thirdly, what we considered of primary consequence, ample space for practical work for the students, because I should say that at that time which I am speaking of, 25 years ago, there was no such thing in Oxford as practical work in science, except Buckland's geological excursions. And I may perhaps take this opportunity of recording a fact, which I also do in a most grateful and kindly spirit. It is a disagreeable fact to record, but I had better record it. I instituted a practical class in anatomy and physiology in Christ Church, giving up the whole evening to it, at 7 o'clock onwards till sometimes 11 and 12 at night, when my pupils, some tutors or professors, and several young men would work with me, anatomically determining the grounds of classification of animals, giving them an animal to dissect, and thus finding out why it was so classified. This was my plan of proceeding with them at that time, making them afterwards histologically demonstrate to me with the microscope the ultimate parts of animals, in fact, interesting them generally in the study of the animal kingdom in a practical manner. I received official notice that this proceeding was not a lecture which by the statutes I was bound to deliver, and my salary for that half-year was stopped. I honoured exceedingly, and I still honour—I have a sense of gratitude for the manliness of the then Dean of Christ Church, Dr. Gaisford, the great Greek scholar, who caused himself great pain by this act towards a wilful young man, as he considered me, but did it with a conscientious view to his public duty. He had the view that a lecture was to be given, and that this was not a lecture,\* and, therefore, it was his duty not to pay my salary. I was working for my livelihood, and dependent mainly upon my exertions for the maintenance of my family, so I was obliged to give a formal lecture on alternate days to recover my salary, which I by that process did. I mention that, because it was the origin, I believe, as far as I know, of real practical work in Oxford. I was so certain this point must be carried, that rather than not do this thing I would have left the place. Nothing should have hindered me from doing it. In this spirit we decided to construct laboratories and workrooms, as well as a lecture room, for every department. There was not money to do this, and therefore we, from the first, being unhappily limited to this sum of 30,000*l.*, were obliged to cut our coat according to the cloth, and to erect those several departments on such a scale as we were able. We arranged what has since been considered a source of discredit to us, but which is of the utmost consequence, room for extension at the back of our building. We provided what we thought at that period to be the most necessary, but made it an essential condition with the architect at the outset that one side should be given up entirely to extension. You will see at the east end of the building a blank wall, which ignorant persons sometimes satirize. I merely mention this to the Commission that if through the influence of this Commission or any other external body or by internal energies, we wish to extend our building to treble or quadruple that size, it can be done. We shall merely have to enter the new department, when completed, by knocking a door through that blank wall. We can extend to any amount without disturbing the existing accommodation in the slightest degree. As I hope that the Universities in England may go on a little while longer, I look with some satisfaction to the fact that since then the University have bought 80 acres of land, some behind and some to the north of the museum. Probably I shall not live to see it all covered with a

\* It ought to be recorded of Dean Gaisford, that as much as from 40 to 50 years ago he required every undergraduate in Christ Church to attend a course of Physics, to write an abstract thereof, and be examined therein. And I may be permitted to record that, as far back as 1847, Mr. Alderman Sadler, now aged and blind, engaged Baden Powell, Daubeny, Walker, and myself, to lecture in the Town Hall, on natural science, to the working classes. Some 500 or more attended the lectures.

scientific institution. I should like to say one more word upon the question of extension, and it is this. We have, in the few years that have elapsed since we began, materially extended our plant in two directions. First of all the Radcliffe trustees allowed us to transfer the contents of their great scientific library from the splendid old Radcliffe library, which you all know, together with their foundation, that is, the librarian and the assistant librarians. Therefore at once we started, I will not say with a complete, but with a great scientific library. Just as we started with the Buckland collection, and with the Christ Church collection, Mr. Gladstone and Mr. Sidney Herbert, with the other trustees, looking forward, increased the grant for books from 200*l.* a year to 500*l.* a year, that is for books only, without the salaries of the officers. Then with regard to the arrangement of the building: the instructions to the architect for making this design were prepared by those who taught in the several departments. The Commission will observe that, although it is very easy now for us or for anyone visiting us to criticise our proceedings now that the egg has been broken, and that it is seen how it was done, yet it was not so easy a matter for a number of gentlemen having different workshops, or no workshops at all, dispersed all about the town, to combine them into one whole. The way it was done was by each person stating his wants. For instance, in mineralogy, the present estimable and able officer of the British Museum, Mr. Maskelyne, who was of the utmost service to us, and was then quite a young man, stated his wants in mineralogy. We had very little help at that time, as I said, from the Professor of Geology, though he afterwards came into the scheme; but he did not live at Oxford, and later he became ill. Then one of the professors, Dr. Daubeny, resigned the Professorship of Chemistry, and he left the arrangements for the chemistry to our present professor, Sir Benjamin Brodie. He, taking a large view of the matter, proceeded at once to make a very extensive plant for the chemical department. The Reader in Experimental Philosophy, Mr. Walker, whose health was not good, indeed he was getting on in years, took a somewhat limited view of his department. This was perhaps fortunate, because, having elected a few years ago a new professor, well known to several members of the Commission, Professor Clifton, it was found absolutely necessary wholly to reconstruct the department for physics. Here is an interesting illustration of the way those things go when they are sincerely and heartily done. We were able conscientiously to represent to the Clarendon trustees that the present holder of this professorship, Professor Clifton, was a man of that kind, and that the department was a department of such a kind that the Clarendon trustees, who had by accident complete control of certain funds, thought that the best national object that they could apply them to would be to allow Professor Clifton to build a place for his own researches and teaching out of the large fund that they could give him. By our architectural arrangements we were able to extend here, there, and everywhere. I am again happy to say that Mr. Gladstone, being one of the Clarendon trustees, at once agreed to this, and Professor Clifton has a charming place now erected, which he will describe to the Commission when I have done. There is one other department upon which I should like to be allowed to say a word, because that was constructed in a curious way too. The Professor of Anatomy at that time also being the Regius Professor of Medicine, was a most genial person. He was also one of those who did not think that this kind of development was of much consequence or much needed, but, being a kindly man, he allowed the Lee's Reader in Anatomy to go his own wicked way, and provide for him, the Professor, any amount of necessary or unnecessary accommodation which he thought fit. Instead of doing what he might have done, opposing it, he only laughed, and allowed a very considerable institution to be built. This, in the progress of time, fell into the hands

H. W. Acland,  
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F.R.S.

12 July 1870.



J. W. Acland,  
Esq., M.D.,  
F.R.S.

12 July 1870.

of my able colleague, Professor Rolleston. It was just ready for him when he became ready for it, and he walked in with all his apparatus into some 17 or 18 rooms. I am delighted to add, he sometimes attacks the unfortunates who provided them as being insufficient for his purposes, but we hope to find ourselves in the position of aiding him in an extension to the north-east, as Professor Clifton is extending to the north-west. I am afraid that these historical records may be more interesting to me than to the Commission, but it is a national affair that I am dealing with, and I am sorry to say, as I have hinted before, I am perhaps almost the only person who is in a position to supply this information of the early history of that which is destined to do a good deal of national work before it has finished, so I think I may presume to lay such a sketch before the Commission.

2882. Is the library accessible to the public?—The library, as I before stated, is the old Radcliffe Library, the property of the Radcliffe trustees, and therefore is not under the control of the University. The Radcliffe trustees, when they agreed to transfer their library to the museum, retained the power of admitting whomsoever they pleased and whensoever they pleased. The Radcliffe librarian is charged with the duty of admitting persons at any reasonable hour up to 10 o'clock at night, and, therefore, as the Radcliffe librarian, it is a great pleasure to me, and has been now for 15 years, to see our tradespeople amongst our students. One of the best botanists in Oxford is one of the best makers of portmanteaus, and one of our first electricians is a glazier that I used to see go past my window with his basket of tools in his hand. Both of those have attended the library for years. In fact the library is as open to the city and the county as it is to the University, and the University cannot close it. I do not mean to imply that they would if they could, but I merely mention the fact that they cannot.

2883. (*Professor Huxley.*) Were any questions besides scientific questions a ground of opposition?—Yes, there was a good deal of opposition, some I believe quite conscientious, to this development of scientific work, or rather I ought to say the development of the machinery for scientific work, for I hold myself to have had the fortune to devote a great deal of my life to the humble toil of making machinery of which I shall never see the complete working; but it was a work which ought to be done in my time, and it was that which I was bound to choose. One ground of opposition was that we were æsthetically incompetent, that we preferred Gothic, and cared only for a foolish kind of Art. That ground of opposition was unfounded. We, having settled on the best information that we could get, namely, the opinion of each professor, as to what he wanted, laid those particulars before the public, invited a competition to the whole world, and would not allow any kind of restriction as to style or material. We honestly and painstakingly took the best design we could get. We could do no more. But having done that, I am perhaps one of the most chargeable. I felt that it was not a matter of indifference, either to the country or to the University, whether this scientific building was or was not of equal æsthetic value with the other old buildings of the University, and I did not choose that those gentlemen, who devoted their lives to the prosecution of material studies, so called, or the department of physical science, should be housed in a worse way, according to the ordinary standards of taste, than those who pursue their studies in the Bodleian or in the halls and chapels of our older colleges. I confess, therefore, that I found it my duty to support to the uttermost the artist who was selected in a public manner. If there is anything wrong in what the artist did, then all the worse, I say, for the artists and architects of England, that they did not offer us a better man. I believe that the condition of our dissecting rooms at our hospitals, and the kind of wretched accommodation which was thought to be fit for medical students in many

of the hospitals in the metropolis, and in other places which I have visited, has been a perfectly unnecessary bar to the progress of physical science in this country. For my own part I care not one farthing whether I work in a garret or worship in a barn, but when it is put to me as a matter of decency towards the profession in which I happen to be engaged, I would say that I do not choose to admit on public grounds that we are to be put here, there, and anywhere, and lodged anyhow. I do not say this for myself, but for my subject. I was determined, and others were as much determined, not for ourselves, but for the subject, that, if it was located in a great university, it should be located on the same terms as the other departments.

2884. Why was no provision for the study of botany made in this scientific building?—The reason was a practical one. We have a botanical garden, with its botanical museum in another part of the town, but we hope, and this matter has been discussed of late again, that now that our institute is, as far as it has gone, a great success, and has taken its place amongst the scientific institutions of the country, we shall see the botanical garden removed to the "parks." It was not possible when we began, but we hope that it will be done.

2885. (*Chairman.*) Has opinion in Oxford changed much with respect to the importance of scientific studies?—Within the last 25 years, to which period I am very much limiting myself (it would have been endless and unnecessary if I had gone into the whole history of science in Oxford, dealing with the foundation of the Royal Society, and so on),—within the last 25 years opinion has become quite changed. Physical science is now just as much a part of the study of the place as any other subject, not numerically so extensive, but truly just as much a part as any other department. I have no fear for its due progress. I think there is a Darwinian process in all these matters. There will be a power of selection of its own particular work. I have not the slightest fear for the scientific department having its fullest and completest place in the general course of studies of the University.

2886. Has the kind of work done by the scientific staff altered much within your recollection?—I stated to your grace some time since that when I began 25 years ago there was in fact no kind of practical work done there. There were lectures, and it is true Dr. Buckland took out his students on interesting geological excursions, which was practical work. Dr. Daubeny might have now and then let a student go into his laboratory with him, and get some kind of practical instruction; but, speaking generally, there was no means of practical work for students in Oxford. Therefore, the professors did not work with their young men as they do now. Now, I should say that a characteristic of the scientific work in Oxford is, that the professors live and work with their men, and that, whether it be right or whether it be wrong, practical scientific study is of the very essence of the work which we do. That has entirely arisen within the last quarter of a century.

2887. Can you give the Commission any idea of the extent to which science is studied in the University as compared with other branches of study?—The professors in the several departments, who will appear before the Commission, will be able to answer that question in more detail than I can pretend to do, because they can give the actual numbers in their classes. I cannot numerically answer that question, and I think I had better leave it in detail to my colleagues.

2888. I think we understand that science is studied to a very considerable extent in the University of Oxford?—Far more than would be supposed by those who draw their information from our class lists. You will find, on inquiring from Professors Clifton and Brodie and Rolleston, that a number of their men pursue, and I think most fortunately pursue, the study of physical science for the love of the subject, without



any regard to the examinations, and that the number of persons who appear in their class lists, which is the clue that the public take constantly, and where they commonly see only two or three, is not a clue at all. Far more study than appear upon the class lists, and the professors will explain the reason of that.

2889. Are there any obstacles which retard a reasonable share of attention to the study of science?—It is said by many persons that the mode of election to the fellowships is a reason why there are not so many scientific students, and not so many scientific experts in Oxford as there are classical or mathematical experts. I do not know that that is a fair way of stating the case. I doubt it. The changes which take place in a country are necessarily very slow. This University was originally engaged entirely in the subject matter of the age in which it was operating, and at one time, as we all know, almost the whole of human learning was in what is called literature, and in mathematics. There is no doubt that the origin of those institutions in this country from the learning of the ecclesiastics is at this moment in some respects a disadvantage. But that is a question to be handled with extreme delicacy. To the ecclesiastics we owe the existence of these great foundations of thought. They naturally had their own conditions, and there were no other men of learning. But rapidly those relations are being changed. I do not entertain the slightest doubt that if our scientific teachers are left alone, there will be no occasion for forcible alterations. I do not think it would be just for me to say that either the old ecclesiastical arrangements, or the old arrangements of fellowships, are a positive bar to a fair amount of scientific development. I may be wrong about it, but that is what strikes me. Looking at it as a matter of history, when I see the wonderful changes that have been made, and see that they are still going on, I do not entertain a doubt but that in one way or another the scientific departments will receive from the University all that the University can properly give, having due regard to its other duties. It has many other duties to perform besides duties to physical science. In fact, now, it is a very rare thing, I should say, for the last four or five years, for the scientific department to apply to the council or to convocation for anything, and to meet with an adverse vote. I have not looked into the statistics of this, but as a matter of fact we know now that we carry almost everything. I think we are, as we ought to be, careful not to be too exigent.

2890. Are you able to give the Commission any information as to what becomes of your scientific students?—The question of what becomes of our scientific students is a curious one. The late much respected Lord Clarendon, put to me a question having the same significance, in the old Schools' Commission. It was remarked, with some justice, that supposing physical science were introduced into schools, there would be a difficulty in finding teachers. The answer that I gave to that was, that so far from that being the case, if there were many more posts for scientific teachers required, it would relieve me from the great anxiety which I felt as regards the future of our young men. We may, by our new institutions, and by the urgency of the public about scientific study, press a number of our able men to devote themselves to a line of life in which they cannot get a maintenance. Therefore, I think that it is a matter well deserving the attention of this Commission, or of any other commission, to consider what is to become of those young men whom we persuade to devote themselves to new studies. A good many who have passed through our natural science school at once take up the position of teachers. If I were asked to say what I desire to be the outcome of the Oxford Museum or Institute, I should say, it would be, first, the providing a class of well-educated, well-conditioned, large-minded teachers of physical science to be dispersed through the country. I am reminded of a discussion which arose between myself and the vice-chancellor, Dr. Plumptre, who

aided in the construction of this institution, when he asked me this: "You want to have an immense place built here, with great libraries and workshops and all manner of organization; how many people do you think are going to use it?" I said, "That is a most unpractical question, and it has nothing to do with it. You must have a first-class apparatus if you want to have first-class men," and I added that, "it seems to me that in this University of Oxford it should be much more our object to have convenient means of making a class of highly-trained students than any great number of ordinary students, for whom," I said, "all over the country there will be plenty of ordinary opportunities." I think you will find that those who have given some years of study to Dr. Rolleston's work, and who give a similar time to Professor Clifton's or Sir Benjamin Brodie's work, become teachers in different places. In fact, they can always get situations of that kind. The number of men is comparatively small.

2891. (*Professor Stokes.*) In what class of institutions do those first-rate men exercise their teaching powers?—I am sorry that I have not got with me a list which was prepared for me by some of those young men, but I have a list, which I may send up to the Commission, of the different situations that they have got. [See Appendix VII.] I will take, for instance, the case of a person who acted as one of the secretaries to the British Medical Association two years ago in Oxford, Mr. Chapman, a man of property, and not devoted to any profession whatever. He has become a teacher of physiology in two or three of the colleges. He is a person of no profession excepting the profession of scientific teacher. If there is to be teaching in the colleges, you must produce a number of such teachers for them. If there is to be teaching in schools, you must have a number of teachers prepared for them. Mr. Griffith, who was assistant to Professor Walker, has gone as master to Harrow.

2892. Could you give any rough idea of the income that is obtained by this teaching, on the average?—I am unable to do that, but in the last instance that I gave you of Mr. Griffith, he has the income of an assistant master of Harrow. Other analogous cases I know in other schools, but I cannot say their income.

2893. (*Chairman.*) What are your expectations at present as to the extension of scientific studies in Oxford?—When these schemes were originally started, we had, I think, three distinct objects in view, and although after the lapse of years no doubt ideas upon that subject have become more precise and more clear than they were, yet they are still unaltered; at least mine are. We thought that scientific studies should be pursued in the University for the purpose of general education; and as far back as the year 1848, I published a pamphlet, urging the introduction of science into the general education and general discipline and training of the ordinary student, that is, the ordinary culture of a gentleman. I especially desired this for the sake of our clergy. The clergy in the old universities form a very large proportion of their body. It is a matter of great national importance that they should not be narrow men, and, therefore, it appeared to me, for their sake, and I may presume to say also for the sake of the country gentry of England (you will observe persons not of scientific professions at all), that they should have an opportunity, and, as I have before stated, an opportunity in a pleasant and congenial manner, for obtaining scientific knowledge, and the general benefits of accurate training in science, as part of their general education. That was one object. The second object was, the foundation in the same large sense for professional studies on the part of professional men, to which I will revert presently; and then, thirdly, the further proper function of a university, actual addition to scientific knowledge: this being quite a distinct branch, belonging only to the higher class of students, professors, assistant professors, and private teachers. Therefore,

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F.R.S.

12 July 1870.



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there were three departments for which we hoped to provide the general education: the fundamental parts of professional training, and the opportunity for advanced scientific research. I look forward to the progress of our institution of the University in all those directions, just as I had hoped it in former days.

2894. Have all those objects, to a certain degree, been accomplished, or are they in a fair way of being accomplished?—I think that sufficient time has hardly elapsed yet for me to be able to give a complete answer to that. In respect of general education, I wish no doubt that a greater number of our average students availed themselves of their opportunities. With regard to scientific progress, that is, with regard to the devotion of our professors to the advancement of scientific knowledge, as such, I think that we cannot justly expect much more in that direction, unless they have more funds at their disposal, and more assistance given to them. If public opinion is to require a man to be always looking after students, always at work in the students' laboratory, and to be responsible for everything in his department, then public opinion asks what is unreasonable, and will find itself disappointed; and until public opinion is with us, and, at all events, looks upon a professor as a high-minded man who knows his own business and is better able to conduct it than his critics, and knows better what means and apparatus he really requires, and knows how far it is to the benefit of the University that he should be devoted to the labour of research, until that time comes I think that we have no right to expect the highest amount of scientific work from our professors. I think that such persons as Professors Rolleston and Clifton and Brodie run a great risk of being overworked by their teaching, and of being kept away from that quiet life by which alone they can carry forward that second object. With regard to the professional branch of university teaching, the whole subject of professional education in those branches with which I am the best acquainted is in such a state of confusion and transition, that it would be presumptuous for me, especially in the presence of Professor Huxley, to give a very definite opinion, but I should like to be asked some questions upon the subject by-and-by. We have at present no professional instruction, properly so-called, at all, in any department, and the question will naturally arise by-and-by whether that ought to be superadded to scientific teaching proper.

2895. Are you satisfied with the present arrangements of the so-called natural science schools?—With regard to the natural science school, I presume that that term is understood by the Commission as being the arrangements for the examination of the students (that is the way in which we use the word school). These were based upon a theory which I will endeavour very shortly to state, because, with Daubeny, Walker, and Maskelyne, I was mainly instrumental in putting them into their present shape. We thought that the best arrangement for the natural science school was this, that we should consider that there were three fundamental subjects in that school, exclusive of mathematics, namely, physics, chemistry, and biology, which at that time we called physiology; that those three subjects should be the only subjects which pass men should be allowed to take up, and that for honours the students should be allowed to take up any subject they thought fit, if they passed in those three subjects which we considered fundamental. I believe upon the whole that that system was right; it is one of those things of which one can only say *solvitur ambulando*. That was the best hit that we could make at that period, now many years ago, and upon the whole I have no doubt that it was right. Then the Commission will observe, that the choice lay between that and allowing students to take up anything they pleased, which I think some of my colleagues even at this moment wish; but I believe it would be entirely wrong to allow a pass student to take up what he pleased, to take up entomology if he

liked; I object to that. Any university students being of the kind that I mentioned just now, would, I hope, be fundamentally trained men. I would see that they knew elementary mathematics, and that they were sufficiently trained in all the fundamental subjects, before I allowed them to go amateuring in advanced subjects, not knowing the basis of those to which they proposed to devote themselves. I sincerely hope, therefore, not to see the broad principle of our natural science school changed; but I am sorry to say that there is a difference of opinion about it. For instance, the late Professor Strickland, the eminent geologist, who was one of those who worked with us till his unhappy sudden death, was displeased with me because I would not admit geology into the pass school, but I could not do so on principle. I said, no, he must be an anatomist, he must be a zoologist, he must be more or less a physicist, or a chemist, or he shall not call himself a geologist. I sincerely hope that neither the weight of this Commission, nor of any other will at present break up this arrangement, with this exception, that I think that in the progress of knowledge, chemistry and physics ought to be allowed to stand alone, but I do not think I would force the chemist or physicist to pass in biology. I am obliged to admit, as a matter of argument, that a student ought to be allowed to take chemistry and physics without being compelled to go into biological subjects at all. It would be very little hardship for him to be required to do so, but I think probably we shall be obliged to allow the chemical and physical departments to be independent of biology. The biologist will still be obliged to see that his student has passed through the pass school of physics and chemistry.

2896. (*Professor Huxley*.) Would you not think it desirable that even supposing you permitted a pupil to pass out in physics and chemistry alone, you should insist upon the person so passing having had a certain acquaintance with the principles of biology, at an earlier stage?—That introduces another very difficult question, namely, the studies which should be taught and mastered at schools. If we are to launch out into that question it would raise so many others that I at present shrink from it. I think it may become necessary, but yet it will be a misfortune, if our students in physics and chemistry obtain a university degree in science without any knowledge of biology. As an educator, I do not wish a man to be called one of our scientifically educated students who does not know a vertebrate from an invertebrate. In answer to the professor's question, whether I think that in order to secure that, the best way would be to require him to have had his biological studies at a previous period, that is a very difficult question. At one time I thought it was very easy, and I wrote a paper to that effect upon the teaching of physiology in schools, but I am not now sure that it is the better way. I would not pledge myself against it, nor in favour of it, at present.

2897. Do you think that there would be any difficulty in giving sound practical instruction in the elements of botany, as illustrative of the principles of biology in school, before a boy came to the University?—I think on the whole none at all. As at present advised, I am not at all sure that I could support the proposition for the University making it imperative that they should; but that, as a matter of fact, boys could be taught in many schools, and in most schools, if you like, the elements of botany with very great advantage I have no doubt whatever.

2898. In the course of your extensive contact with men of science has not this often struck you, that while men of your own profession always have a certain amount of sympathy with our pursuits, though they may be very ignorant in the subject matter, it very often happens that physicists and chemists have not the remotest conception of and still less sympathy with our pursuits?—I wish I had any means of giving adequate expression to my assent to that proposition; but I think it a far greater misfortune, I must say, to the physicist and to the



chemist than it is to us, for this reason, that whereas we are obliged, speaking as biologists, however imperfectly, to endeavour to know what we can of the rudiments of their sciences, they, in the nature of the case, remain, or may remain, entirely ignorant of some of the most wonderful phenomena of the laws and processes of the world in which we live, and that they may stop short of knowing any of the relation of the subject to their most perfect and complete manifestation, which we, on the biological side, however imperfectly and miserably we may do it, cannot remain in absolute ignorance of. That is the reason why, as I have said twice already, I shrink from laying down the law that our students should be allowed to take a degree in natural science and be entirely ignorant of even the principles of biology.

2899. Of course my question was entirely meant to suggest that this deficiency which I allude to could not possibly be an original sin in the men of ability that we were speaking of, but simply arose out of the method of their education never bringing them into contact with these things?—Certainly.

2900. (*Dr. Sharpey.*) When you speak of degrees in natural science, is that a new institution in Oxford?—I did not use that term quite correctly. I said it for simplicity. I used the term as synonymous with the *testamur* of the students who passed out from the natural science school, but Dr. Sharpey will observe that at present such a person is called a bachelor of arts. I myself should be prepared at any moment to advocate the separation of the science school and the science degrees from the Arts degrees, always understanding that the science degree with us did mean one who had passed through whatever should be decided upon as the proper amount of arts culture. But we have at present this awkwardness, that a person who is really an accomplished physicist, and mainly that, or an accomplished anatomist, is still called only a bachelor of arts. There are difficulties in old institutions in rapidly altering such things, but I think the time is coming in which attainments of this kind ought to be distinctly recognised, and have a distinctive title, other than a degree in Arts.

2901. Would it be practicable to require, as a qualification for a junior degree, that general culture of which you spoke, not only in literature but in the different branches of natural science, including biology, and for a more advanced degree, such as doctor of science, that the candidate might go out upon some special subjects, as by that means you would ensure the general culture and a general acquaintance with science before you gave your *testamur* at all; but in the advanced degree he should be encouraged to proceed further in some particular special branches. You are probably aware that in the University of London, although they do not teach science, still, in conferring degrees in science, such as bachelor of science and doctor of science, they follow that rule, and that the examination for bachelor of science is more general but less deep, whilst for a doctor of science the candidate has an opportunity of taking particular branches?—I think that some arrangement of that kind will hereafter, and probably before very long, be quite necessary. I think it is in the very nature of things, but I would draw Dr. Sharpey's attention to one circumstance (at least I presume to remind him of one thing which he well knows), that we have, I think, to consider at present, as a primary trust to the nation, the education of a superior class of men, and we are responsible for the way in which that trust is carried out. I am afraid it is considered by some an antiquated notion, but I think we are responsible for the way in which they attain the knowledge, as well as for the way we test it in examinations. The test by examination alone is good, but it would be more perfect if it could include the way in which a man has reached the method of answering the questions. I confess that I would not be satisfied unless we supervise the successive steps by which he has reached them. I think, in short, an entire revision

of the sequence of studies both in schools and universities is necessary, to avoid waste of time and repetition.

2902. Are you aware that in the University of London it is done by successive stages, that a bachelor of science has three examinations to pass—first, matriculation, then a first examination, and then a second?—Yes, I am aware of that.

2903. (*Professor Stokes.*) You stated that the University of Oxford contributed originally 30,000*l.* for the building of the new museum; the building cost, did it not, considerably more than that?—The building cost considerably more than double that.

2904. How was the rest of the fund raised?—By successive votes of convocation. I may state that the way in which the sum of 30,000*l.* was fixed was this, Dr. Cotton, the vice-chancellor at the time, said that he thought he could get a vote passed for 30,000*l.* (I suppose that there was then a surplus, but I do not know what it was), and we, therefore, were pledged to lay before the University a plan which could be carried out for 30,000*l.* It was imposing many inconvenient limitations upon us, which we are very sorry for. The 30,000*l.* was for the bare building. It did not include internal fittings, which I had calculated at from 15,000*l.* to 20,000*l.* above the first amount. Then there was the cost of the site, which was 4,000*l.*, and the drainage, and various extras besides. I do not know the total cost, but I imagine that it was altogether somewhere about 80,000*l.*, without the cost of maintenance, and, with the various things that have been done ever since, it cannot be very much under 100,000*l.* that has been expended upon it in the last 20 years.

2905. The whole of that came from the University, did it not, in its corporate capacity?—The whole of that came from the University in its corporate capacity, that is to say, the grants for the museum proper. But then there is a great deal more property invested in this institution than appears by that statement, because the Commission will observe that when I talk of the expenses, that does not include the salaries of the professors; Professor Rolleston, for instance, receives his salary from Merton College. The office which Professor Rolleston holds (giving this as an illustration of what I mean) is one which has been founded since I was Lee's Reader in Anatomy, with its 200*l.* a year. In the process of the development of our plan, aided I doubt not by the influence of the old University Commission of the year 1854, the different colleges founded different professorships, and amongst others the Linacre professorship just mentioned. That annual charge, or the capital which it represents, is exclusive of the cost of building. This is the case in other instances, such as the Magdalen College professorship of chemistry.

2906. You spoke of classical and mathematical and physical fellowships; are we to understand by that that a particular fellowship is thrown open to competition for classical men, and that another is assigned to mathematics, and another assigned to physics?—Yes, that is so; but that is not done by the University. It is a point of college administration. I do not think that I am a good authority on general affairs of the University of that kind, but I can give I believe to this particular question a correct answer. Take the case of Christ Church—they have lately founded a readership in physics, in addition to the readership in anatomy, which was the only readership in science in Christ Church when I was Lee's Reader of Anatomy. There was only one Lee's reader, whereas there are now three, viz., a reader of anatomy, a reader of physics, and a reader of chemistry. When, therefore, a person is elected to a readership in Christ Church, which carries with it the funds of this one college, he is appointed either for anatomy, for physics, or for chemistry: so in other cases, when a person is wanted to teach mathematics, he is elected to a mathematical fellowship; but the particular legal way in which the funds are appropriated varies in the different institutions, just as the sources from whence the funds came have varied.

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2907. Does the University in its corporate capacity defray the cost of the maintenance of the museum, not including the stipends of the professors?—Yes, and not including of course the Radcliffe library, which is managed in the way I have mentioned.

2908. (*Dr. Miller.*) How much is expended annually by the University in the maintenance of the museum?—Professor Phillips, the keeper of the museum, who keeps the accounts, will answer that. I could not with accuracy.

2909. In what kind of way is it distributed; is it for the maintenance of all the different collections in the museum?—There are assistants in the several departments who have to be separately paid, and then there is a sum generally voted every four or five years for the maintenance of the collections, which is distributed by the professors amongst themselves acting by a delegacy as their respective wants seem to make it just, settling the proportions practically among themselves.

2910. For instance, the maintenance of the laboratories of the chemistry professor and the professor of physics, is there any special endowment or allowance for that purpose?—No endowment: the Professor applies from time to time for grants.

2911. Does that come out of the general fund, or does the professor find what is necessary?—It comes out of the general fund of the University by a vote; but there again we get into minute detail. There is a small and old fund attached to the professorship of physics for the purchase of instruments, which is still continued; but it has been, I think, about 90*l.* a-year, and therefore it is merged into the larger sum, but the professor gets it amongst the rest, it being an old foundation. And, of course, I might observe that each of the professors who are coming before the Commission will be able to answer exactly the sums that they receive, and the way they receive them, each in his own case.

2912. (*Professor Stokes.*) You spoke of four subjects which were specially considered in the original construction of the museum. Will you have the kindness to state what those subjects were, and to say whether any other subjects are now included?—The four principal collections which were transferred to the museum were those of the old Ashmolean Institution, mainly zoology, the cabinet of physics or experimental philosophy, the Christ Church collection of anatomy and physiology, and the geological collection of Professor Buckland at that time; but the subjects represented in the museum at this moment are, besides those, mathematical physics, geometry, astronomy, mineralogy, chemistry, and medicine—in all 10 professorships.

2913. (*Dr. Miller.*) You were speaking of the difficulties which the University professors at present experience in the pursuit of original investigation. Can you give the Commission any idea of the way in which those difficulties might be best lightened, so that they should be capable of pursuing original research?—It seems to me that the simplest way of getting the most out of the abilities of a first-rate man, and out of the money which is at the disposal of the University, would be to make grants to the professors for such purposes as they believe would be desirable for the progress of their subjects. As it has been suggested that there would not be time to go to-day into my own department, I will only just say that if I wanted to get additional work done in my own department—which I should be very glad to do—the way that I should prefer to have it would be, not by at once founding a number of professorships, which might or might not turn out 20 years hence to have been the best course, but to be allowed to utilize, in such a way as I thought fit, a sum of money not exceeding some determined amount. For instance, I will show how much can be got for a little in that manner without endowing or founding anything. On representing to the Radcliffe trustees what I have now stated, three or four years ago, they have allowed me to get con-

structed by Powell and Lealand the best microscope that those gentlemen could produce, as a standard instrument. They allowed me a moderate sum to get histological demonstrations given in their library. For that sum Professor Beale, a great authority in certain departments of microscopic work, came down and gave a number of lectures and demonstrations during three terms. It did not suit him to continue the work for a longer time. 70 to 100 students of either sex, both townspeople and University residents, attended. The Radcliffe trustees would probably make a similar grant for any other useful temporary purpose. In that way I would undertake to get in my own department much useful work done for a very moderate sum. The other plan would be to take up capital to found new professorships, or to provide permanent assistants in the several departments. In a word, I should like very much to see all my colleagues trusted by the University to use such and such sums of money, or sums not exceeding so much as they thought fit, and if they thought fit; I would not compel them to use it, but I would allow them to use it, if they thought fit, for a period of four or five years. I think that that is a much better way of proceeding in the present transitional state of education in this country and in the Universities, than proceeding to appropriate this fellowship or that fellowship, or this fund or that fund, to some specific subject which very likely a few years hence, may turn out not to be the permanent use of the fund.

2914. Do you consider that the combination of teaching with investigation is better than the pursuit of investigation alone by the same man; do you think that an advantage or not?—Speaking generally, I suppose it is a great advantage, and I should have been sorry to have said anything to imply that I thought that an eminent investigator had better not also be a teacher, but to compel him to give such and such time to the drudgery of teaching I should think very undesirable. I would let him do it if he wished. I would give eminent men as much liberty as they wanted, that is to say, I would let them teach or not teach, because men are not always exactly alike, and my feeling is not to lay down rigid rules in the matter. One man may do it easily, a man probably of robust health may do it simply for refreshment after his labour, whereas another man is killed by it.

2915. Did I understand you to say that the University require this kind of continuous work on the part of their professors, or is it optional on their part?—It is optional to a certain extent. Professor Rolleston spends many hours a day with his students at their practical work. Anybody who knows him, knows that when he does spend an hour he spends as much labour as most men spend in six. That is purely from his sense of duty, and then when the vacation comes he is perfectly worn out. He would deny it, he would say he was not so, but was as vigorous as possible, but he constantly looks quite ill, simply from his laborious teaching.

2916. You stated that you are required to give a certain number of lectures: it is I suppose generally the case that there are a certain number of lectures prescribed for each professor?—Yes, but those regulations are very various. Personally I am not required to give any at all, and, from circumstances which I will not now enter into, I have considered that the most useful thing that I could do for the public was that I should not at present give systematic lectures, but only clinical instruction. I might have come to another conclusion, but I have thought it better that I should not. But in the case of some they are compelled to give a definite number of lectures, but that number of lectures is usually very small, and I think quite insufficient for what I should call the ordinary hack work of teaching. I think that usually it is about 12 lectures in a term which they are required to give, and if that means an ordinary demonstrative course of lectures, very likely you would consider that number sufficient, but to



many men it is a great burden. Professor Ruskin, whom we lately elected, gave six lectures as his first course, but he is bound by the will of the founder to give 12, and I earnestly desire that we may find the means of not requiring him to give 12, because I see that he will scarcely be able to do it. At least, if he is compelled to give 12 original lectures a year, they will be of much less value to the public than they would be if it were left to him to give five, eight, or ten, or what number he pleased. The number seems few, but it depends entirely upon the kind of work which is done by the man who produces it. Only if you allow that altitude to the chief of the department (it is not I hope presumptuous in me to express such an opinion before eminent teachers), the chief must himself be responsible for his assistants, and for seeing that what I may call the ordinary mechanical work of teaching is done. In that way, also, you train up a series of successors, or of young men accustomed to teach.

2917. Do you think that that is really the most effective way of dealing with those two classes of persons?—Yes. For myself I do not know how teaching can be economically or properly done without it. That seems to me to have been the case with all the departments with which I have been acquainted. Taking an illustration from my own department, I remember well when old Sir Benjamin Brodie used with the perfection of his matured experience to come to St. George's and give three or four clinical lectures with his hands in his pockets, sitting down and in an easy way doing that which had taken some 50 years to enable him to do at all, and which probably no other man in the country could have done anyhow. But then to bind a man by a statute because he got 200*l.* a year to give 30 or 40 lectures would be simply to make it impossible for him to do other work besides which perhaps nobody else could do.

2918. Still I understand you to say that there is great latitude given to the professors?—There is great latitude in allowing them to do as much work as they like.

2919. And the want is assistance?—The want is assistance.

2920. (*Sir J. P. Kay-Shuttleworth.*) You made some allusion to the imperfections of the mechanical resources which are placed at the disposal of the medical schools in London for teaching biology and other cognate subjects; may not that have some effect upon the introduction of young men of the superior classes of society into the profession of medicine?—I do not remember exactly that the expression to which you refer is in my previous evidence, but if I understand the general tenor of the question rightly, I suppose that you wish me to express an opinion as to whether or not the scientific training given to the best kind of men in our universities would not be a useful introduction to the studies in the hospitals?

2921. I do mean that, and likewise socially, as facilitating young men who have pursued the literary branches entering the scientific studies, before they go to the special studies of their profession?—I entirely agree to that. I think it is very much to be desired that in the general development of education at the older universities, and ours amongst them, men should be prepared by literary culture and scientific study to go elsewhere to seek those opportunities for practical study which, in the nature of the case, we cannot so well give as they may be given, for instance, in the metropolis. And, in answer to your specific question, I may say that I have always hoped to see a class of superior men, men of natural ability, thoroughly trained, who would go from our scientific school to attend the great hospitals in the metropolis and other great cities.

2922. So that the training of a great physician would consist, probably, in his first taking honours as a classic and as a student of mathematics, and he might then enter upon the practical scientific courses which are now connected as a centre with your museum, and then, having taken a physical degree in the University, he might proceed to

the more special schools of medicine in the metropolis?—I believe that that would be the typical way, and that typical way would be for the best men; I do not say that it is the only way. A strong man may be educated in any way; it does not much matter in what way you educate him so long as you leave him alone; but for an ordinary man of good abilities, that would be the typical way from which you might have to depart in various particulars, but generally I should recommend that. Only that implies time, and that implies money, and the consequence of that is that you cannot expect, I am afraid, to have in the present day a great number of persons able to do that. But, as I said in a previous part of my evidence, I think that the numbers in our case are entirely a secondary consideration, looking at the thing in a national point of view. I think it is our duty, as I understand it, to add to the quality that you have, and secondarily to the quantity. That is my conviction. I should be sorry if that opinion should be taken or could be construed into suggesting any hindrance in the way of any person or any number of persons coming who are able to comply with our conditions. I wish the general practitioners, the surgeons, equally with the physicians, and my friend the portmanteau maker, who is an excellent botanist, to have and to use all available opportunities. These should be free to everybody who can use them in the sense that we wish, viz., in the most complete manner. Only that implies time and money.

2923. Reverting to the voluntary students who make use of the public libraries, they have likewise afforded to them facilities for practical study in the museum, and, seeing that they are in contact with men devoted to a great extent to research, do you not conceive that those circumstances are favourable to the cultivation of habits of observation and research amongst the class of voluntary students?—To the growth of knowledge and to the promotion of habits of accuracy, of course.

2924. I am accustomed to the phenomenon of the struggles of men of genius who have no opportunities excepting those which they make for themselves for mental cultivation, and none of contact with men who are engaged in scientific observation or in experimental research, and the intention of my question is rather to ascertain whether or not the existence of such a museum, served by such professors as the museum has, would not for the area to which it extends greatly facilitate the studies and the success of such men?—It would do so if we had a large strong and healthy population, the same as there is in the north. The different conditions of institutions must be looked at in a large and comprehensive way in order to rate them quite rightly. If the museum at Oxford, with its present plant, were situated in Lancashire or Yorkshire, in the midst of the large and vigorous population there, its apparent results in the direction to which you allude would be enormously greater. There is not a question about it. I should have to provide more room in my library and the practical laboratories would not be large enough, and so forth. All manner of things would happen which do not happen with us; and therefore unless our population and the class of our population immediately around Oxford should very materially increase, I do not see that the same kind of fruits can possibly be produced as would be produced under other circumstances, such as the circumstances of Manchester, or Liverpool, or Bristol, or some of those other places. But we should produce equal fruits and greater fruits by another method, namely, as I said in a previous part of my evidence, by the sound training of thoroughly good teachers of large culture, who would then go to their several destinations, whether as gentry or clergy, to do good in their stations in various ways. I see this is so already. Although this institution has existed for so short a time, I could point to persons already of eminent station in one way and another who will be of great service to the progress of science, both in the legislature and out of it, on the bench, and elsewhere, from having come in

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contact with the general scientific culture offered to them by our staff. But that would be a different kind of fruit to that which as I said would be produced in the centre of a great population like Leeds, or any place of that kind. We have no such people. We have very few intelligent active mechanics. Although, as I said, our library has been open for many years to men of all stations, the numbers that avail themselves of it are few. There are not the requisite numbers. We are in the middle of a very thinly peopled agricultural district.

2925. I intended to advert to the great benefits of the museum in training teachers in a subsequent question, but I might be permitted to presume that you would conceive that even the establishment of an inferior institution for scientific instruction, with an inferior library of science, in such a centre as Leeds, or Newcastle, or Manchester, would in the respects to which I have adverted, and also as a means of general cultivation, be of great importance?—The highest, without question.

2926. And, regarding the peculiar power of the population by which it would be surrounded, such an institution would be followed by results which you cannot hope for in such a centre as Oxford?—I entirely agree to that.

2927. Whereas, on the other hand, you have in Oxford the means of cultivating all who come up for the literary degrees, and diffusing through them first a general knowledge, and then preparing a class of special teachers for local institutions?—Yes.

2928. Seeing that it is well understood to be one of the objects of the Endowed Schools' Commission to create first-grade modern schools, in which scientific instruction is to form a prominent feature, I apprehend that you would expect that in the course of years students trained in the laboratories of such schools, under teachers educated in the museum at Oxford, would come to you and to other centres of scientific instruction?—Yes, certainly. It has been an object with me that all the persons who come in contact with the scientific departments in our University should come in contact with an institution whose general tone, if I may say so, of culture was such as I should wish to see planted in different parts of the country. We have aimed at the same thing in our hospital. We determined that we would make improvements in the administration there such that our clergy or our noblemen or our country gentlemen or persons of influence who went from us to other parts of the country, might take with them a standard which they should desire to see in their own several districts.

2929. If the existing endowments of the periods of Elizabeth, Edward VI., and Charles, which hitherto have had a primary literary application in grammar schools, were diverted to a considerable extent, by the operation of the Endowed Schools' Commission, to scientific instruction, and first-grade modern schools were founded, you would see the absolute need of the great centres of education providing a class of men who in all respects should be worthy trainers of youth in those first-grade modern schools?—Yes, that is quite necessary.

2930. Besides the funds to which I have adverted as being thus applicable, the force of public opinion would probably cause funds in the colleges of the two Universities to be applied to increase the amount of scientific instruction in colleges?—Yes.

2931. And I apprehend that, although you would wish no sudden interference, you have no doubt that opinion will be so affected within those Universities that such funds will in a short period be so applied?—Of course that is a question of detail. It has to be borne in mind that recent progress has not been going on, either within the Universities or in the country at large, without affecting very much the sentiments of those who have a voice in the administration of their respective institutions, and I must say that, contrary to the general opinion outside, I suppose that if you were to seek for liberal and conscientious

men with a large view of their duties as connected with the education of a great country, you could not find more sincere or better men than you will find in almost every college in Oxford. I feel quite satisfied upon that point. I would instance such a person as the present head of Christ Church, who is a man of large views, like the late head of Trinity College, Cambridge. He is not devoted, it is true, to physical science, his chief occupation being as a scholar and lexicographer; but there is not in England a person more sincerely desirous to devote his energies to the reasonable extension of the scientific department. He has found opportunities for the advancement of the scientific departments as much as he has for the classical and artistic, of which he has given ample evidence through the whole of his career. I do not doubt that, as time goes on, there will be a perfectly just public opinion upon the subject to which you refer.

2932. Without entering into details, and having regard only to the need that scientific instruction should form an element of the instruction of gentlemen and clergymen in the Universities, is it not clear that you cannot accomplish that in the degree in which you would wish it, unless some of the funds of the colleges be applied to that instruction within the colleges?—That seems to me to be again a question very much of internal administration. It opens also a question of very great and peculiar difficulty indeed, that is to say, the way in which we are to extend our scientific staff. I have not had an opportunity of saying anything on that point beyond what I remarked, that I thought that the head of a department should have a certain quantity of money placed at his disposal to use in what way he thought fit; but I should like to take the opportunity of showing how carefully we must go to work in extending our professorships. The habit hitherto has been for some college to found a professorship, when required to do so by the late University Commission. One college, for instance, would found a professorship of chemistry, and another would found a professorship of modern history, or something of that kind. If that were done under a central administration, and that central administration were thoroughly well informed, and really knew what it was about, then the devotion of the funds no doubt would always be useful, and there will be no waste. But unless great care is taken we shall run the risk of founding permanent professorships, when perhaps assistant professorships, or temporary or terminable lectureships, acting under the chief professor, might be much more useful. In fact you might order the colleges to devote so much money, and in the absence of a generally concerted scheme, have a great deal of waste. And in addition to that, I should like to be allowed to put on record this—that for the proper promotion of science in the University of Oxford, I think that one of the first objects should be to get our scientific Institute, or Museum as we call it, to be recognized as the head of the scientific department of the University. Nothing should be done in the extension of this department, or in the regulation of scientific education, excepting with the concurrence of the staff of the Institute. I think that colleges should not be required or allowed to found assistant professors or lecturers of this, that, or the other department, excepting entirely in concordance with the great plant which we now have, or you will really have waste, and you would have what is a great deal worse—you would assuredly have disputes. I see considerable danger of that.

2933. Having all that in view, I have rather a desire to refer to the obvious necessity of increasing the tutorial power under the professors of the museum, and the possible connexion between that tutorial power and the respective colleges, so that the tutors who worked in classes at the museum might likewise assist the students of the respective colleges to which they belong, and so a harmony of action might be produced between the museum and the colleges?—I think that that may be made to work perfectly well.



and that the plan is one deserving of all attention, and that something of the kind must be done; but it would be exceedingly difficult to carry out in detail without creating many difficulties, unless it were, as I have said, part of a general organization. Otherwise, we should have a great risk of the college teachers being in opposition to the University teachers.

2934. The difficulty I apprehend being in the creation of any central power by which all those several resources might be made co-ordinate and harmonious?—Yes. I would give an illustration of that, because it can touch no existing office; namely, an instance which I alluded to before, by the way, in the course of my evidence. Although I was the only teacher of anatomy and physiology for 15 years in the University, yet neither would the University recognize me as a professor, nor would the college allow me to be so recognized. When a board of studies was proposed for regulating the natural science school, by accident the hebdomadal council put down the Lee's Reader in Anatomy as one of that board. By accident they did so, forgetting their duty to the University in recognizing a college officer. When the late Dean of Christ Church became aware that his reader had been put into this board of studies he erased his name. Now the reason of that is obvious. It is no blame to anybody. The funds belonging to the college and not to the university, he thought that those who held the funds had a right to say what their officers were to do.

2935. At the same time you foresee the necessity of such a central power?—Yes, certainly, by common consent, and on settled terms. A suitable central scientific body exists in the museum at this moment.

2936. (*Professor Huxley.*) To turn to the question which Dr. Sharpey put to you some little time ago, although of course there are no specific scientific degrees in the University now by the present scheme, it comes practically to very much the same thing, does it not, that is to say, after passing in moderations, a man may take his degree exclusively in science?—Yes, only nominally and by title he takes his degree in arts.

2937. The subject of examination for that arts degree may if he chooses be purely scientific?—Entirely so.

2938. The degree which he gets is a B.A. degree?—Yes, a B.A. degree.

2939. But in practice it is a scientific degree?—It follows a scientific examination.

2940. So that in reality the scheme of examination now is not so different from that of the University of London, to which Dr. Sharpey was alluding, as it looks, for you might put the moderations upon the same level as the matriculation examination which every bachelor of science in the University of London has to pass through, because in the University of London, as you are aware, a candidate in the first place has to matriculate, which is very nearly upon the same footing as moderations, and afterwards he can specialize and go out entirely in science and take his degree as bachelor of science, and practically this arrangement would seem to come very much to the same thing, except that it does not openly recognise science?—Yes, that is so unquestionably. But I think that the arrangements for the course of study require reconsideration from the first. I think that, as I stated before on another commission some time ago, we require some authority which shall settle what shall be the subjects of examination on leaving the schools, that is, on coming to the University, and what option shall be allowed. I would allow considerable option, but it ought to be clearly known at the schools for what to prepare young people intended for the University. I would allow considerable latitude, but if a person is going out in the scientific department of the University, it ought to be perfectly well known at Winchester or Eton, or wherever it may be, that that boy cannot be allowed to go into the natural science school excepting he has passed such and such an examination. It should be understood that he is to be qualified in so much mathematics, in so much classics, or so much logic. This

is merely a question of arrangement, only that the several parties have to be agreed amongst themselves. Lastly, such an anomaly as having an arts degree for an exclusively scientific examination should of course be brought to a close.

2941. You are doubtless aware that in the foreign universities, the German universities particularly, there are such persons as extra-ordinary professors; persons devoting themselves to particular lines of inquiry, who are allowed to have a certain status in connexion with the University as lecturers with regard to that line of inquiry?—Yes.

2942. There is nothing of that kind in the University of Oxford, I think?—I think that that would be a solution of a great part of our difficulties, and would be a very judicious way of expending our funds. In my own department, to which I alluded just now, I should wish for very little more than to have the power of instituting such a class of persons. If I may be here permitted to digress so far, I would say that I think that strictly professional studies had better, upon the whole, be carried on in the metropolis. I think that we require a class of scientific persons who should not be nominated in perpetuity, but appointed for four or five years. I should like, for instance, in my own department to be able to appoint a person to give lectures and demonstrations on comparative pathology for five years, and if he did it well I would reappoint him, but if he did not I would not. And if I then thought it desirable to expend the funds in some other way, in experiments in therapeutics and in experiments in materia medica, for another period of five years, I should like to be able to propose it to my colleagues at the Museum. They would then accept the proposal, or we should agree upon some other subject to be taught, such as ophthalmatology, or any other that would be to the advantage of the public of Oxford and of the country at large. But that would be an entirely new step with us, and one which it would be probably hopeless yet to attempt to carry out in the University for some years to come, excepting by help from some external authority.

2943. Supposing the authority of the colleges were of the same mind with reference to this matter, would it not be very easy for them to give fellowships to persons who were specially qualified, and to let them hold those fellowships during the time that they were engaged in teaching as extra professors?—We English are a curious people, and it is very difficult just now to make any regulation by which one man shall be empowered to direct another. So, as I have said, the regulation of extra or assistant professorships requires great consideration. Miss Burdett Coutts, not 10 years ago, founded a geological scholarship; she was so good as to consult me concerning the terms on which this scholarship should be founded, and one of the conditions which I recommended was that the scholar should reside a year in the University. The object of that suggestion was that the professor of geology should have a skilled assistant who had got his place by competition, that this youth would be engaged in cataloguing, describing, drawing, and in doing work in our museum, which should qualify him to be a better geologist than he was before. Within five years this arrangement was rooted out as an act of oppression; that it was a restriction or something or another which was intolerable, and there was a statute brought forward to say that he need not reside. Of course he was delighted and off he went; so we have no advanced resident student in geology and no assistant professor in the department. If you will require those persons to reside and to work, no doubt it would be a good thing for the University and for them, but we really require public opinion to support us in this matter. That is an explanation of the little criticism which I made just now about Dr. Gaisford. Dr. Gaisford said to me, "Sir, if you are to have 100*l.* for your course of lectures, you shall come into Oxford; you shall reside six months, counted by days, and if I catch you a day out, I will stop your salary, and if you do not give the lectures that Dr.

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"Lee in 1750 ordained I will stop your salary." But now many holders of fellowships go here and there; reside and do not reside; and do this and do not that; if we attempt to impose regulations upon them, there is a clamour. Miss Burdett Coutts' scholar resides, perhaps, in London. It may be good for London, but it is fatal to us.

2944. But there is already, is there not, a sort of precedent to the suggestion which I was throwing out in my question in such an office as the Lee's readership in anatomy and chemistry; to take the case of Mr. Harcourt at the present moment, he is what in a German university would be called a professor extraordinarius, is he not?—Yes, practically he is. Then comes the collegiate question which I alluded to just now, in answer to Sir James Kay Shuttleworth. You see that that depends entirely upon the goodwill of Christ Church. That institution is anxious to do its duty to the country in respect of science. But then the museum has no power of regulating its arrangements. It has no power over it at all, and therefore I mean that it is quite conceivable that the person acting as assistant professor in a college might say, "I will do the same as the University professor; it is all very well for the professor to lecture upon metals, I too shall lecture upon metals," unless there is some arrangement to prevent that; I believe that "law" means "arrangement." I do not much trust to voluntary arrangements, at all events not now; it is not the temper of our time at all. If you mean to make extraordinary professors, that is to say, collegiate professors, permanently useful, they must, as I said just now, be made so in combination with the central authority at the museum. May I be allowed to add this, which I feel it is due to us all to say, that at present there could not be a more harmonious or happy set of fellow workers than we are in Oxford. We have no difficulties, or nothing worth calling difficulties at all; there is the most hearty good feeling and harmony among the scientific men. What I am saying now is in the way of looking forward to future development or reconstruction. How am I to prevent (seeing the difficulties which I know must arise unless they are met by forethought and organization) a great waste of money and a waste of years, on the part of the next generation?

2945. But my suggestion rather went to this, that the University professors would give a general course adapted to the education of the ordinary students of the University as a whole, and then the voluntary efforts of persons holding fellowships and acting in this capacity of extraordinary professors would tend to develop particular branches, as, for example, a person appointed to a fellowship for distinction in chemistry might think fit to take up a special line of investigation, we will say the ethers, and he might think well to give 6 or 12 lectures upon that particular advanced branch of chemistry; do not you think that if something of that kind were done the University would be able to supplement its ordinary instruction on the one hand, and on the other hand to give very powerful encouragement to the original investigation?—Yes, I think so; and, farther than that, I see clearly how it should be done. The museum should be considered as a scientific institute; no scientific arrangements of that sort should be made, as I said before, excepting with its concurrence. It should not be possible to expend scientific funds except with the concurrence of that institute. In return for this requirement all those gentlemen so appointed should be part of the museum delegacy, or museum administration, whichever it may be, although they do not actually teach in it. They should have, so to say, equal rank or power of voting (on terms to be considered) with the central scientific body, but they should not be authorized to do exactly what they pleased; they might do it if they liked, but not by our consent; and in that case they would be outside the general scientific corps.

2946. (Sir J. Kay-Shuttleworth.) But there would probably be a greater chance of harmony if the scien-

tific readers or teachers of the respective colleges were also members of the tutorial body of the museum?—That would depend, would it not, a good deal upon whether there was accommodation for them, and upon the nature of their work? I should make them part of the managing body, as I said, in the same way as though they were in it. I should give them a seat at the board of delegates, and they should be summoned to their meetings, and altogether I would make them part of the scientific administration of the University; but I would not go so far as to say that they should necessarily be teachers in the museum. It might be more convenient that they should be located elsewhere.

2947. (Professor Huxley.) I imagine that you would agree in the view that, quite apart from the mere teaching apparatus in the University, an enormous indirect stimulus to work would be given by the residence in the University of a body of men engaged in original research, and whose names were known in that capacity outside the limits of the University?—I think that what you say is so absolutely true that I do not think, unless some such arrangement could be made, we really can ever be of the full value that we should be to the country; and the strength of my conviction upon that point was my reason for telling that apparently trifling story about Miss Burdett Coutts' scholarship. By venturing to give her that advice nine years ago, I meant to get in the thin end of the wedge of a good principle, that is to say, to get a class of middle men who should be resident in the University, working under, if you like, or by the side of, if you prefer it, their scientific seniors. I do not know any large teaching institution, whether an hospital or a scientific institution, in Europe or elsewhere, where the very life of the institution is not in great measure fostered by the public opinion of rising young men. Unless we can somehow or other have that aid, I should despair of our Institute fulfilling its full mission in the country; but the question is how to bring this about. Young men of ability gravitate to the metropolis. It will be an advance in civilization when they are contented to be spread more evenly through the country.

2948. Can you tell us about how many students per annum can be accommodated in the existing teaching apparatus of the museum per annum?—I mentioned that we were originally limited by 30,000*l.*, and therefore our lecture rooms are small; one for each of the several departments, and one large lecture room to hold 500, which might be used by anyone who had a specially large class. I believe that the several small lecture rooms combined would hold perhaps not quite so many as that. Each department has similar practical workrooms. I think Sir Benjamin Brodie can accommodate about 24 or 28 students in his practical laboratory at the same time, but then they do not come every day; and Professor Rolleston, having several rooms for various purposes, a somewhat larger number.

2949. I presume I am speaking well within the limit when I say that not more than 40 men could pass through this science teaching apparatus in a year. Can you say what is the number in any given department who pass through it, and also the number who are prevented by reason of their not having had actual room for practical work?—That question shall be answered by letter hereafter. I have not the data with me. [See Appendix IX.]

2950. I judge from a reply which you have previously given, that you have no inclination towards connecting technical education with Oxford; you would have no desire to connect with Oxford an engineering college, or a mining and metallurgical institution?—I am bound to say that at one time I thought that in some of the departments it might be desirable to attempt it; but as I have grown older, although I think it is quite possible to do it, I do not think it would be any real advantage to the country. I am quite sure that the best service that we can do to the country is to make it as complete a



place as possible for general scientific study, without regard to the use to which the students put their scientific knowledge afterwards in their professions. I feel convinced of that; and though I do not say that the other is impossible, and I should be very glad to join it if other people wished it to be done, yet I should not advise it. Take the case of my own department. Of course I could have a clinical department at once, and I would undertake to organize it; if you give me a little money for the purpose you shall have an "interne" clinical department and an "externe" clinical department, with all necessary arrangements, within 12 months; but if I am asked whether that is of any use, I should say very little, although it can be done. And so of the other departments. The professor of law would tell you the same thing concerning law. He would say, study the general principles of law; give the best literary and historical education you can, and let the student come to the law courts and the chambers of the great law practitioners of London. I would say the same thing of medicine, and I presume, although it is out of my department, that I might say just the same of practical engineering. I cannot conceive that it would be worth while to try and get up engineering shops at Oxford, when you could send a student off to Whitworth or Fairbairn. I would give him a thorough scientific training, and send him where real work was being done for a practical object. A town like Oxford could, however, furnish, on a small scale, sufficient illustrations of scientific principles, in most departments of practical work.

2951. (*Mr. Samuelson.*) You have stated that the provision for the maintenance of the museum and of the persons engaged in teaching is derived from a variety of sources, would it be possible for you to give to the Commission either an estimate of the entire sum devoted to those purposes, or to furnish a scheme of what would be required for the maintenance of an institution like that which you have now in Oxford?—With regard to the first part, if the Commission will be so good as to direct the secretary to send me that question specifically, I will take care that you shall have a return. As to the second part, namely, what would be required for such an institution, I would venture to say that the better way would be to ask the question of each of the professors as they come before you, the professor of chemistry, the professor of physics, and so on, because it would be presumptuous in me to say what would be required.

2952. But there would be a number of general charges, which after all form a very large proportion of the cost of such an institution, which would not be special to any one of those subjects, and of which it would be desirable to have an estimate?—That shall be furnished also, always understanding that it would only be my personal opinion. I could not pledge the University to it, because it is a matter for convocation.

2953. You have stated that you think it desirable that the institution should be the authority for scientific study at Oxford?—Yes, I think so.

2954. In how far is that the case at this moment?—Nothing hardly would be done at this moment without consulting the delegacy of the museum. I should wish to say that by the present arrangement, although great exception was taken to it at the time it was instituted, there were six persons appointed by convocation, who may or may not be scientific persons, and they alone have votes. The scientific professors are members of the board, but they are not allowed to vote, and they must influence their colleagues as well as they can. I think that is a very good arrangement, and I have no objection to it whatever, for this reason: when this body was appointed for the administration of the affairs of the museum, it was not thought well to have a large committee or delegacy to manage it. It was proposed to make three of the scientific professors working in the museum, members of the body for managing their colleagues, and I foresaw that that would produce,

and necessarily so, such dissatisfaction that the only thing was that they should be all in or all out, and the authority of the day said, "Very well, then, they may be all in if you like, but have no votes." So the Dean of Christ Church and myself, and others, at once closed with this. It works perfectly well, and it has this great advantage, that we might, as I have said, add any number of professors or extraordinary professors that we like to the managing body, without the slightest jealousy on the part of convocation. You will observe, in short, that the body which manages the scientific institution is an authority composed of the whole of the scientific branch, only they do not vote; and of six members nominated by the governing body of the university, the convocation. This arrangement answers exceedingly well.

2955. In addition to the care of this special institution, what are the functions of that delegacy, in how far do they direct what is to be the curriculum of science in the University of Oxford?—I am sorry to say not at all. I have not the slightest doubt that one of the functions of that delegacy ought to be a board of studies, so as to regulate that class of questions which I alluded to just now, in answer to Professor Huxley. The delegacy ought to have supreme power in regulating the course of scientific studies, or at all events in recommending them to convocation, convocation being, like the Houses of Parliament, our ultimate appeal. Under our present constitution, we can propose nothing in convocation, nor even ask a question there. The power of publicly asking questions, as in the House of Commons, would be a powerful engine to us.

2956. In addition to that, do you think it desirable that they should have some control over the internal arrangements of the colleges as far as they have reference to scientific studies?—Before any addition to the scientific teaching staff was made by the colleges I think that it ought to have the concurrence of this scientific staff, that is to say, if that scientific staff is really to be responsible for this part of national education.

2957. Would there be any precedent for that in reference to the control which the University exercises, or any delegation of the University, over the colleges with reference to the faculty of arts?—No, not of the same kind, but virtually, I think that, from the circumstance of the colleges providing the funds for the university professorships, as in the case of the professorship of Latin, and the professorship of physiology, which I alluded to before, and many others, it is the same thing. The college, in these cases, gives to the University the income for the professors. Then, the professor is not under the control of the college, but under that of the University.

2958. This proposal would very seriously affect the organization of the University as far as scientific study is concerned; in your view, is public opinion within the University sufficiently ripe for such a change as that which you would like to see effected in that respect?—I think so. I do not know if I overrate the influence of the scientific element, or estimate wrongly the power of what I may call the old opposition to it, but my impression is that any judicious step for the improvement of scientific teaching in Oxford, thoroughly matured and considered, would in all probability carry the votes of convocation, and it is a question of votes; according to their present method of proceeding in that, as in the supreme legislature, questions become at last merely a question of votes. Suppose, for instance, it were proposed to found a professorship of comparative pathology at the expense of some college. I do not know at all which way the majority of votes would go in that college. I have a shrewd suspicion that it would go against the professor of comparative pathology. I cannot myself at all coincide with those who very quietly propose to settle exactly the way in which their neighbours are to distribute their funds; it is a dangerous doctrine, and I must know the exact question to be proposed before I presume to give an opinion

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upon it; but generally I should say that any judicious scheme for the improvement of the scientific plant would be carried by the University. I understand, however, from those who know the state of the funds of the University, that at this moment they are entirely pledged, and that there is not much available surplus in the University chest. Professor Price knows exactly the details of this department, but that is what I understood to be the case, that out of the University funds, properly so called, there is no more to be got, so that it is no use to propose it. If funds are to be got from the colleges, as I stated, it clearly should be done by consent, and on a thoroughly well considered plan.

2959. But taking the colleges and the University as a whole, you are of opinion that no great amount of external pressure, if any at all, would be required or would be desirable in order to bring about the acceptance of such a scheme as the one which you have set forth?—It is not possible for an individual, at least not for me, I think, to give an opinion worth anything on a very nice point of legislation such as that, because it is a question, as I said before, of taking the funds of one body at the will of another. We might, I think, do this. It would be perfectly possible, and indeed probable, to have that kind of public opinion which should put a limit to the non-residence of persons holding offices. Take this case, and I own that I personally feel very keenly about it. I have a highly intelligent young man working for me now in the laboratory which I have arranged for my medical department. I pay him myself his salary (a small one, it is true, but I cannot give him more), and he has to provide his own board and his own lodgings. Meanwhile, there are persons with fellowships entirely non-resident whose rooms are empty. I confess that I sometimes wish that my young friend, who has not good health, could occupy one of those rooms; but, on the other hand, I see clearly that it must rest with the proprietor of the rooms, and not with me; it is a large question of administration.

2960. But the question upon which I was rather anxious that the Commission should have your advice was this: had the public better allow the University to work this thing out for itself, or should some external influence which need not be specially defined at present be brought to bear?—I think that is a question which rests with the Government or the Commission rather than with me.

2961. In what way do you think that the reform for which you are anxious would be most speedily and satisfactorily accomplished, by leaving the University to mature a question of this kind itself, or by an endeavour to bring public opinion or legislation to bear upon them *ab extra*?—I very much wish I could give a more direct answer to that question or any question of the kind; but I must say that it seems to me to be a matter so very much of general policy that I hesitate to give an opinion. I remember that the famous Mr. Seward spent two or three days with me some years ago, and he looked at our museum; he went over it with me in great detail on a Sunday afternoon in the long vacation, and he said, "Well, you have done a great thing here," I said, "Yes, and we did it voluntarily." "Ah," he said, "you will never do another; you will not go any further than this." Of course I gave him as answer, "But do not you see what we have done voluntarily." I really do not know that it would be at all becoming in me to say that those who through a long series of years have been endeavouring to do their best to meet the progressive wants of the country, do require this external coercion. I know one thing, that if they try to make me do much more than I do now they would very soon have me out of the way for somebody who might do it better. I have done all that I can do, and many others do the same.

2962. We may hope that laboratories and museums somewhat resembling the one at Oxford may be established in some of the large centres of population in various parts of the kingdom, and in order to enable

those who would have the charge of such erections to judge of the probable expense, it would be desirable that it should be known what portion of that expense was due, in your case, to architectural decoration, and what to the actual wants implied by the subject?—With reference to architectural decoration we have spent scarcely any money at all. I have no doubt upon the whole that an equally serviceable building with the same amount of cubical contents could be got much more cheaply, and for many localities quite suitable. The case of Oxford was a peculiar one, and I need not repeat what I said before, that there was a certain clear national duty in respect of the surroundings of a national institution of that kind to carry it out in a certain way, but it was still cheaply done, excepting in respect of the decorations. These were all gifts. The beautiful columns, which were selected in illustration of British rocks, all the statues, and all the carvings throughout the building, were individual gifts from individual persons, got by endless letters and persecutions, to which I admit that we subjected our friends all over the country. The Duke of Argyll gave one column, Mr. Gladstone gave one carving, Mrs. Gladstone another, the Queen gave five statues, and Mr. Ruskin's father gave one, the undergraduates one, and so it went on. The decorations did not cost convocation one farthing; they were the result of the kindness of valued friends. The carvings in front of the windows, which are the quaint humour of a rough working man, and which Mr. Fergusson, therefore, considers execrable, were done at Mr. Ruskin's expense. In a mere business building they might be out of place. You might have a building of the same cubical contents, and the same facilities for work, no doubt, for less money, and I guard myself by the previous part of my answer against the supposition that, therefore, the University squandered money; it did not pay for it; they only spent 100*l.* in carving upon the whole building.

2963. And with a very creditable architectural elevation?—Yes.

2964. (*Sir J. Lubbock.*) Will you favour the Commission with your opinion as to the best course to be pursued at the great public schools with reference to scientific instruction?—I think the course to be pursued at public schools must be very much like that which I have implied as proper to be pursued with us. I think that it should be considered whether you are going to teach boys for the purposes of general training and culture for general purposes, or whether you are preparing them for a scientific life. There is a fallacy in the public mind upon that point. They sometimes do a great deal of injury to boys at the schools by letting them go into popular or semi-popular scientific courses, which may be very proper for the purposes of what I may call general education or culture, but it may be an entire waste of time for a boy who is going to pursue a scientific profession. I will give a simple illustration of that. Supposing a person to come to Oxford to work in Professor Clifton's laboratory of physics, it is quite clear that the thing which he most wants is intelligent training in mathematics. It is a mere waste of time for him to have to work in what is called a practical laboratory, if he comes up to Professor Clifton untrained in general literary culture, and without any mathematical taste or power whatsoever. I think for the purposes of general culture our large schools can quite easily have a scientific department attached to them, as I believe they have at Marlborough at this moment, and at Rugby, and at Harrow, and at Eton.

2965. Considering the usual age of boys at public schools, do not you think that a general training is of more importance than a particular application of science?—Yes, speaking generally, I should say so.

2966. Would it be necessary to establish museums at the great public schools from that point of view?—That would, of course, depend entirely upon the extent to which you wished to carry on your teaching. I would give one very simple illustration, that of a



young man who was trained by myself from boyhood, Mr. Charles Robertson, now very well known as demonstrator of anatomy with Dr. Rolleston. He is an able and excellent person. He prepared for the Great Exhibition in Hyde Park a series of dissections illustrative of the animal series generally, comprising some 40 or 50 examples. Those were intended to be typical of the kind of dissections which the larger kind of schools might have, and he sent them to the great exhibition for that purpose. Professor Rolleston has lately published a book, containing the dissections of some of those and other specimens, showing what really can be done in that direction. I, therefore, do think that typical illustrations might be easily prepared under proper direction for the principal schools of the country. I think there would be no difficulty, without launching into heterogeneous museums, in providing typical illustrations of various parts of biologic science for the training of boys.

2967. Might such collections be supplied from the British Museum and other institutions?—Typical examples of external forms, speaking of the biological department, still might be got no doubt from the British Museum and other institutions. The dissections, which I spoke of, exhibiting the internal structure, of course must be made under competent supervision, and not at any very great cost. We would undertake to furnish as many sets of dissections as you like; if you give us the order, we will be happy to execute it.

2968. Then what do you think should be the nature of the collection in such museums as you have alluded to?—Would not that compel me to go into the question of the subjects which should be taught and how they should be taught? I think that my colleagues, the professors of physics and chemistry and of anatomy, who are severally coming before you, perhaps would be more competent judges of the extent to which their several subjects should be taken.

2969. I should have been glad to have had your opinion also if you could express one?—I think that in each of those subjects which I have just now mentioned, there would be no difficulty in preparing collections well suited to illustrate practically any standard works, or the lectures of any good teacher. The collections should contain only typical specimens. They should not profess to show the extent of science, or the minutiae, or the novelties of science. There would be no difficulty in providing such collections for any department; but I should say that they ought to be provided by eminently skilled judges and teachers. Supposing you propose this scheme to the country, I should not like it to get into the hands of, so to say, tradesmen. It must be done under supervision, and under the supreme direction of thoroughly competent teachers.

2970. (*Sir J. Kay-Shuttleworth.*) It had better proceed from the central school, for example, taking the museum at Oxford, they should prepare for the public schools?—They might easily do that. The same thing is done, or a parallel thing is done in respect of Art, with more or less judgment and splendour by South Kensington. I would express no opinion about the selections sent out one way or the other; but we have in that method a precedent of the Government sending out specimens for study all over the country. It will always be a question of judgment whether the selected specimens are the best or not. They might be made to illustrate standard works, and be varied as editions are varied.

2971. (*Sir J. Lubbock.*) Do you consider that instruction in such branches of science at public schools should be simultaneous or successive; that is to say, do you think they should be going on together, or that it should be taken up in different parts of the school?—If you mean at different periods in the school life, that would be a question for the administration of the head master. I fancy one ought not to lay down an absolute rule about it. The boys have very different talents, and different degrees of

force. I think the going into the scientific department should be voluntary, subject to the general advice and direction of the head of the school. One should not lay down an absolute rule that they must do it in the fourth form, or the fifth form, or not till the sixth. I should myself wish to leave it very much to the taste of the boys.

2972. But if instruction in those branches of science is to be a matter of general training, it would hardly be desirable to leave it optional with the boys?—I thought you asked me with reference to the time they should begin; I should make it not actually optional, but considerably optional as to the time. Of course, if you require all boys to go through the science school, they must do it at some time or other. Some would begin earlier, some later.

2973. But in a great school, like Eton or Harrow, there must be some general system adapted to the average mental condition of boys, must there not? It would be difficult to have some boys learning chemistry, we will say, in the early part of their school career, and others in the later. One can hardly adapt it to the different idiosyncracies of different individuals?—I should be very unwilling to express an opinion that every boy ought to be forced into this science school. I should not like to express the opinion that every boy ought to be forced to learn either Greek, or German, or mathematics. I should not like to lay down an absolute rule to that effect, but I believe the time is come when it should be the general order of a first-class school, excepting there were reasons to the contrary, that at some period of their school duties, if it were so ordered, boys should go through the science department.

2974. You do not see any difficulty, I infer, in combining literary and scientific instruction in the great public schools. You would still regard the literary instruction as necessary, though not perhaps to the same extent as at present, would you not?—That is part of the large question of school administration. Some persons think that literary schools should be distinct from scientific schools, as to a great extent they may be said to be in many parts of Germany; but I do not myself see that it has been shown that there is any difficulty in having both branches going on in a large school, such, for instance, as Marlborough. There I understand that the system works perfectly well. The head master told me so himself; and I do not see any reason why other schools should not have a modern school at work simultaneously with the other. Of course it is a matter of internal regulation, as to how much of general training is to be required before boys go into the modern or science school. It is simply a question of detail, and I see no difficulty in combining them.

2975. (*Mr. Samuelson.*) Do you mean in combining them so far as the school is concerned?—So far as the school is concerned.

2976. And also as far as the individual is concerned?—Exactly. I am very strongly against Greek being made compulsory upon all members of the medical profession. It is very desirable, but it is very difficult to lay down an absolute rule for all. I should say the same of science in a general school.

2977. (*Sir J. Lubbock.*) You mentioned that although the Radcliffe library is open to the public very little use is made of it. Is that due to the absence of interest in intellectual pursuits, or is it that the existence of the privilege is not made quite sufficiently generally known?—I am afraid that I must have seemed to state that too broadly. It is perfectly true that the library is not used by any great numbers, either of the citizens or of the university, but I suppose that that is only from want of numbers of students. All students in the natural science department come in to get what they require. They have great facilities, they take books, to compare with the specimens, from the library to the court where the specimens are. We study their con-

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venience to the best of our ability and judgment; and, although it is true that the townspeople come, and always have come ever since the privilege was granted

The witness withdrew.

ROBERT BELLAMY CLIFTON, Esq., M.A., F.R.S., examined.

2978. (*Chairman.*) I believe you are Professor of Experimental Philosophy in the University of Oxford?—I am.

2979. Will you be so good as to explain to the Commission the position of physics in the curriculum of the University?—Physics, chemistry, and physiology are the principal branches of science recognised in the natural science school. Other branches, such as geology and botany, may, at the option of candidates, be introduced into the examinations, but only in addition to one or more of the branches I have mentioned. This school stands very nearly on the same footing as the classical school; the only difference, I believe, as far as honours are concerned, is that those going in for honours in the natural science school are obliged to add a little to their classical work in moderations.

2980. What is the general nature of the school?—A natural science school.

2981. What provision has the University made for teaching physics?—Certain rooms were allotted for the study of physics in the new University museum, but these having been found insufficient, a distinct building for physics is in course of erection, in fact is erected, and nearly ready for use. I have brought with me some photographs of the detailed working plans (*handing in the same*).

2982. Was this building erected under your directions?—Yes, as far as the internal arrangements are concerned.

2983. And you think it will prove satisfactory for the teaching of physics?—Yes, I think so; at all events it will make a good start. Perhaps I may say a few words to explain the building. The building has been divided into three segments, so that it can be used by three or four teachers working simultaneously, with a view to a future extension of the staff. The three segments may be treated as separate departments for distinct studies. On the north side, on the ground floor, are rooms intended for the study of heat, with a balance room attached; on the first floor, on the north side, the rooms are devoted to electricity; and the south side is entirely devoted to optics. There is, besides, the lecture department, represented by a theatre and lecture room, and cellars attached. The whole of the arrangement has been designed to enable a number of men to superintend special subjects simultaneously, without interfering with one another. I think that the plans will explain themselves.

2984. What has been the cost of this building itself and of the fittings up?—Between 10,000*l.* and 11,000*l.*, but that does not include apparatus.

2985. But does that include all the internal fittings?—Yes, all the internal fittings, or very nearly so. I hope they will all be done for the money; that is the amount of the contract.

2986. What do you expect the apparatus can be provided at?—There is a large quantity of apparatus already, and there is a sum annually available for the purchase of apparatus; a special grant of 1,000*l.* has also been made from the University chest.

2987. Can you name what is the annual grant for apparatus?—For apparatus it is about 94*l.*; it varies a little as there is some income tax to be deducted, but that is about the average for apparatus only. There are other grants, which I will mention in a future part of my evidence, for current expenses.

2988. Will you proceed to tell the Commission what is the state of things with respect to the University provision for teachers?—With respect to teachers, there are only three University teachers, one of whom has been quite recently appointed. They are, first,

to them about 15 years ago, yet for the reasons stated, as regards our population, the numbers are necessarily not great.

Professor Price, the Professor of Natural Philosophy, who lectures on mechanics and optics treated mathematically; secondly, myself, I teach physics mainly experimentally; and, finally, a demonstrator in the physical department, who has just been appointed, and whose duty it will be to assist me in giving practical instruction in the physical laboratory. When I say that my teaching is experimental, I do not mean that no use is made of mathematical processes; such a course would be simply impossible in teaching physics accurately. I merely mean that the subject is treated from an experimental point of view, the lectures are illustrated by experiments, and instruction in experimental methods is given in the laboratory.

2989. Is it intended that Professor Price should have the use of this building?—No; he never requires any instruments, I believe.

2990. Have you stated to the Commission everything with respect to expenses?—No, not the whole, and perhaps I had better give you the whole at once. When I first went to Oxford a grant was made of 50*l.* a year for lecture expenses, and 110*l.* a year for assistance, to be divided into two parts, one for a skilled assistant (a skilled workman who should assist me in my lectures), and the remainder for any extra assistance that I might require. These sums were sufficient until quite recently, when, as we were just entering upon the new laboratory, the expenses would necessarily be increased and more assistance would be required. In consequence, the following additional grants were lately made, and, although only made for one year, I have reason to hope that they will be continued, as without such sums annually it will be impossible to carry on the department in an efficient manner. First 150*l.* a year for a demonstrator; that is the person to whom I have already referred. He is a skilled physicist, and is to take an important part in the superintendence of the laboratory. 55*l.* a year for assistance, that is, in addition to what I have had before, and 200*l.* a year for laboratory expenses. So that there is altogether the sum of 565*l.* allowed for expenses for this next year.

2991. That is a large increase, is it not, on the previous allowance?—Before the new building was erected, I had only a lecture room, and it was only possible to give instruction in the laboratory to a very few students, consequently there was not so much required; but there are now, I think, 25 rooms in the new laboratory, each of which will cause some expense, and we shall want more assistants and more servants.

2992. Is the sum you have mentioned a grant from the University chest?—Yes. Then besides that, there is the sum of 94*l.* a year nearly from a special bequest, which is entirely for the purchase of apparatus.

2993. Is that included in the 565*l.*?—No, that is a matter which has been going on for many years. It was a bequest specially for the purchase of apparatus, and it is called the Leigh fund. Besides this 1,000*l.* was granted me last year for the purchase of the principal apparatus for the new building, and when I first went to Oxford 150*l.* a year was given me for three years to add apparatus, but that has terminated. I have had the whole of it. In fact the 1,000*l.* was put in its place in one lump sum, so that I might buy the more expensive instruments to start in the larger building. Those are the grants which have been made within the last four years and a half.

2994. Is there a difference between what has been granted and what has been expended?—Yes. When a sum is granted I may use it as soon as I like, but I have not yet used it all.

2995. There is the sum of 1,500*l.* for providing apparatus, and you have 94*l.* a year from a special



bequest; is there any annual grant besides from the University chest?—No, not now. The 150*l.* was given per annum, but, as I have said, that grant has terminated, and I have had the 1,000*l.* given me in its place.

2996. But you will start with nearly 2,000*l.* worth of apparatus when the money is expended?—It will be more than that a great deal. There was, I should think, apparatus to the value of 1,500*l.* at least to start with. I must say some of it is a little antiquated, and a great deal of money has been spent in models which are of no great use, but still in estimating the value of the cabinet all must be taken into account, so that really the cabinet would be worth, if you reckon the money that has been expended upon it, I should think, at least 3,500*l.* This, of course, is merely my own estimate.

2997. Are you able to tell the Commission what provision is made by the colleges for teaching physics?—I can tell you part of it; I am not quite sure that I know the whole. There appears to be in fact provision made for teaching science with any appearance of completeness in only four colleges. Christ Church has now a staff of three scientific teachers, the three Lee's Readers, as they are called, one for physics, one for chemistry, and the third for physiology; the Lee's Readership in physics is quite a new foundation, the first appointment having been made last Christmas; the others are older foundations. Three other colleges (Wadham, Merton, and Magdalen) have appointed lecturers on science, and they (by an arrangement amongst themselves) take the whole of the scientific students of those colleges amongst them. Each college appoints a man skilled in a special branch of science. For instance, Wadham has appointed a physicist, Merton has appointed a chemist, and Magdalen a physiologist; so that by interchanging the men at different colleges amongst the lecturers, while each college only pays one teacher, yet each college gets the advantage of teaching in all the three branches. Such combinations of college lecturers are now becoming common in Oxford; for instance, several of the mathematical lecturers have combined, and so have been able to offer students a much more complete course, without materially increasing the work of the individual teachers. Besides what I have mentioned, I do not know that any other provisions are made.

2998. Are those college lectureships in any way connected with your professorships?—No, not at all.

2999. What is the course of instruction which you pursue?—I have really two kinds of instruction. When the students first come they generally know very little about the subject, but they probably know some mathematics, some knowledge of which is essential. Then they attend, first of all, a course of experimental lectures (at least I advise them to attend a course of lectures), by which they become accustomed to seeing experiments performed, and also get some general knowledge of the subject; I also recommend some text book which they are to read, and whenever they get into any difficulty in reading they are to bring their difficulty to me. I generally recommend them to do this whilst they are studying some other subject, or even before they have passed moderations; and after moderations, if they intend to take in physics for their special honour subject, they come to the physical laboratory, to study there in quite a different way. In the laboratory they have the apparatus themselves, and are called upon to perform certain experimental processes, mostly quantitative determinations, the teacher of course giving them all the instructions in the detailed use of the instruments. This kind of instruction first of all takes the form rather of physical manipulation, and the accurate use of instruments; afterwards, researches or portions of researches, which have been performed, are repeated. I hope, with the increased accommodation which is now being provided, to be able eventually to add real researches, and to enable the advanced students to do real original work.

3000. Will you state to the Commission the nature of the examination in the school of natural science?—It differs in very few respects from other examinations in science, except that a portion of it is practical. A man cannot get a first-class—at least it is not expected that he should get a first-class in natural science—unless he can handle instruments properly. Of course I speak now of physics. A man before he can get a first-class in physiology must be able to dissect; and if he takes in chemistry, he must be able to carry out at least qualitative analyses; similarly with physics, he must be able to adjust the instruments and use them with tolerable facility.

3001. Do you take part in the examination yourself?—Sometimes. I have been an examiner, but the examinership is a separate office.

3002. You are not a permanent examiner in right of your professorship?—No.

3003. Is the examination chiefly conducted by papers?—There are several papers to which written answers are required, just like any other examination; but a portion of the examination consists of questions which have to be answered simply by performing some process, or arriving at some experimental result. I thought that perhaps specimens of the examination papers might be interesting to the Commission, and I have brought with me copies of the papers for one year. We have two examinations in the year, and these represent one of the examinations (*delivering in the same*).

3004. (*Dr. Miller.*) How many do you examine practically at one time?—We shall be able to examine a good many in the new building. I have not yet been called upon to examine more than four simultaneously. There is a little difficulty on account of the quantity of apparatus that is required.

3005. (*Chairman.*) Have you formed any opinion as to the objects which induce students to undertake the study of physics?—I can judge only by what they tell me when they come and suggest joining the class, and also by observing what they do with themselves afterwards. They generally say when they come to me what is their object. Some come simply because they think that a modern liberal education is not complete without some knowledge of natural science; there are a good many of these. They do not generally spend very much time in the laboratory, in fact they have not time to do so. If they study any other subject very seriously, they cannot spend much time in the laboratory. Those who work longest in the laboratory are apparently intending either to go into the medical profession, thinking physics a fundamental part of their training; or they are studying with a view to going to the bar, where it is thought that a knowledge of science may be useful; or to engineering, or some branch of engineering, where science may be useful. But by far the larger part are intending to be teachers, and, judging by what they do afterwards, the great majority become teachers. Almost every pupil that I have had, who has really seriously done good work, and of whom I have thought very highly, has become a teacher of the subject either in the University or in schools.

3006. How many years do they remain under you?—It varies very much. I should think on the average I may say three years, but I have only four years and a half to draw the average from.

3007. Can you tell what number of students you have under you?—The number of students in the laboratory has been very small, for in fact we had no proper accommodation, and my only chance of teaching practically has been to use the lecture theatre for a laboratory, and to borrow what rooms I could from my neighbours. It is only in that way that we have had a laboratory at all, and therefore the number of students has been very restricted. The number attending my lectures during the last three years has averaged 40. I do not include in that number the strangers or the ladies who have attended. Sometimes a number of ladies have attended, but they are not included; those I have mentioned are really students.

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12 July 1870.



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3008. But you have different courses of lectures, have you not, some for beginners and some for those who have already gone through one course of your lectures?—Yes, I give lectures which are more mathematical. In fact, in many lectures I do no experiments at all. I assume that the students have seen the experiments, and I simply take those experiments for the basis of the mathematical investigation. But the number I have mentioned refers to the course of experimental lectures. This is the principal course, which all students in the department attend at some time or other.

3009. When you speak of 40, I presume you mean University students?—Yes, University students, real students.

3010. Does the number show any tendency to increase?—Slightly; but the tendency is to improve in quality very much. It appears to me that a very different class of men is now attending the science lectures from what was the case formerly.

3011. Can you suggest any means that could be taken to increase the number of scientific students?—There are many ways in which I think this might be accomplished—three especially. We want science really introduced into schools, under certain restrictions as to what the nature of the science taught should be, and we want more scholarships, and perhaps more fellowships. I am not so certain about the fellowships, but certainly more scholarships are required for science. We also want permission for the students to pass the preliminary examinations in classics and mathematics at as early a period as possible, as soon in fact as they are able to pass them.

3012. In order that they might devote themselves entirely to scientific subjects?—Yes; I do not in the least wish the literary part of the training to be cut off, indeed I think too high an estimate cannot be placed upon that training; but supposing that a man is able to come up to the standard to which he is required to attain, at an earlier period than that at which he is now allowed to pass, he should be permitted at once to clear himself of those preliminary subjects, and really start his scientific work earlier. With respect to the scholarships, they would be useful as reacting upon the schools.

3013. Do you think that instruction in science in schools might be promoted by allowing elementary science a place in the early University examinations?—Yes, I think it might very considerably; at present in the schools in which science is taught the time which has been occupied in teaching science counts for nothing in first entering the University; however much a man may know of science, he gets absolutely nothing for it in the earlier examinations.

3014. The earlier University examinations are confined to classics and mathematics, are they not?—Yes, they are confined to classics and mathematics. I think it might very likely be most advantageous to allow a knowledge of science to be offered as an alternative for some part of that course.

3015. Has that ever been under consideration by the University authorities?—I do not know whether it has really been under consideration. It has been a good deal talked about, but I do not know that it has been officially under consideration; in the final examinations for pass-men it has been actually proposed that science should form part of the course as an alternative.

3016. In order properly to develop scientific studies in the University, do you consider that it is necessary that the colleges should co-operate with the University?—It will be necessary, otherwise we shall soon cease to have any funds. The University is rapidly coming to the end of its income, and we must have funds from somewhere if we want further extension. I have no doubt that there is sufficient to carry on the departments as they exist at present, but for any further extension it will be absolutely necessary to obtain funds from some source, and the colleges seem the most proper source, as they will profit by any increased facilities afforded to students.

3017. You stated that four colleges have appointed a certain number of readerships, and appointed also a teacher in science; do you think that that assistance should be afforded in other departments also?—Yes; but I think it would be necessary under any circumstances that there should be a contribution to a common fund.

3018. You mean actual contribution from the college funds in aid of the University chest?—Yes, a contribution from the colleges in some form or other.

3019. Do you think that the scientific scholarships should be at the disposal of the University or of the colleges?—I am rather in favour of some University scholarships, but at the same time the college scholarships seem to answer very well, and they are probably more generally useful than University scholarships would be, at least so far as increasing the numbers of scientific students is concerned. I should like to see some of both, so that we might really judge from experience what the effect of University scholarships would be. I think that scholarships in science may be of immense value as reacting upon schools and as regulating what is taught in schools. I find by the men who come to me from many schools where science is taught that they have acquired some general information respecting physical processes and phenomena without any foundation whatever of mechanics having been laid, and the result is that the knowledge they appear to have is not real knowledge at all. Too much is often taken for granted, and the students do not appear to understand the connexion between the facts with which they are acquainted and the principles upon which the explanation of these facts is based. I think that if the examinations for scholarships were to be restricted in such a way as to ensure that the teaching in schools should be thorough and not of too extensive a range they would do immense good. In almost every case in which I have examined for scholarships, I have found the knowledge of elementary mechanics very bad indeed. There is a certain amount of information respecting physics, but, as is most likely to be the case when the foundation is wanting, a substitution of fine language for logic.

3020. Are those scientific scholarships of recent establishment?—I think they are, but I have been at Oxford for so short a time that I do not know when they were established.

3021. (*Dr. Sharpey.*) You were not educated originally at Oxford, I believe?—No, at Cambridge.

3022. (*Chairman.*) Do you think it is the duty of the University to aid in increasing knowledge by encouraging original research?—Yes, certainly, it is one of the main functions of the University.

3023. Does Oxford do anything in that direction at present?—Very little, I am afraid. I suppose that the professors are officers appointed to increase our knowledge, as well as to hand down the knowledge that we have, but their time is so completely taken up with teaching now that it is almost impossible for them to do anything more than teach, and in fact not to do that as thoroughly as they could wish. I think that one main duty of a university is to promote scientific research, and another is to supply the country with the very best teachers, but to perform both these duties well a considerable staff of scientific teachers is required, and the number of teachers now employed is so small that one must be neglected; to attempt both would be to fail in both. The demand for teachers is now considerable, and is increasing, so that to maintain the supply we have to spend nearly our whole time in teaching.

3024. What steps do you think necessary in order that the University might do its duty in promoting original research?—I think that professors or other teachers, no matter by what name they are known, should be relieved to a certain extent from the amount of teaching they have at present to undertake. This can only be done by increasing the number—either by increasing the number of professors absolutely, independent of one another, or by giving the professors who now exist a larger number of skilled



assistants, who would do a large portion of the work under the direction of the professors.

3025. Between those two methods which would you prefer?—Up to a certain point I should prefer the second. For instance, in the new physical laboratory there is accommodation and a sufficient plant to enable a certain number of persons to teach without interference, but if more than that number were teaching there, I think it would be found that there would be interference, and that the work would not go on very smoothly; consequently, I should like to see the plan of assistant professors under the professor adopted until the existing plant is fully worked, and after that to have new professors appointed, each with his own plant and staff of assistants.

3026. Would the assistant teachers be of the same class as the demonstrator which you are already provided with?—Yes. I perhaps may mention that the demonstrator is the Lee's reader in physics, Mr. Reinold. It happens that he combines both offices.

3027. Are there also other steps which you think necessary with regard to the subject that we have now been speaking of?—One point, which I think of great importance, is, the way in which these officers, professors, or sub-professors, are to be appointed. They should be appointed by people who first of all are thoroughly acquainted with the subject which is to be taught; and I think they should not be altogether unacquainted with the way in which it has been usually taught in Oxford. Very often branches of science are, more or less, restricted by University custom, in a peculiar manner, and if the special meaning attached to the title of an office be not understood by the electors, although acting thoroughly conscientiously, and intending to do their best, they may put another meaning to the title, and supply an article which is not required, the teaching not representing the line which has become customary; disturbance is thus introduced into all arrangements based upon the nature of the instruction which a particular teacher is supposed to give.

3028. How are the professors appointed now?—Almost every professor is appointed by a different board, and these boards vary very much indeed. There is one board for the Savilian professorship, another for the Sedleian, and another for the Waynflete; in fact, I do not know, with the exception of the two Savilians, that any two professors are appointed by the same board. Some of the boards have only one member resident in the University; the Savilian board, I think, has only one.

3029. Is the remuneration attached to the professorships in your opinion adequate?—I am afraid, as a professor, I hardly ought to answer that question. As a general rule, I think that the remuneration ought to be such as to attract the best men, taking into account the social advantage offered to a professor, viz., a life of quiet with a very congenial pursuit. Still, I think that the remuneration ought to be somewhat comparable with a fair success in the professions or in business. Then probably one of the best men may be attracted by having the fair remuneration which he would get by entering a profession, together with the extra advantages which the office would give him, not expecting, perhaps, the same remuneration which he would get if he turned the same abilities to the pursuit of a profession. It is perhaps hardly fair to ask that.

3030. What is your opinion as to establishing a system of pensions?—I think it of very great importance. I believe that the different branches of science often suffer very much, as far as the teaching of our University goes, in the interval which elapses between the real efficiency of one professor and the appointment of his successor. After a man has done a good many years of work, it is not to be expected that he will be able to teach so efficiently, or to keep up with the progress of his subject so well, as when first appointed, and it is extremely hard to compel such a man, after he has spent the best years of his life in the service of the University, to retire without any remuneration

whatever, whereas it is of the greatest importance to science that he should retire.

3031. There is no pension at present, I believe?—No, I think there is no instance of a pension given to a professor at present.

3032. You think that the cause of scientific research might also be promoted by a redistribution of the fellowship fund?—The fellowship fund is a large fund in the University, and one naturally looks to it. It was originally designed for promoting knowledge, and it certainly only does that in a moderate degree now. I think that one would naturally look to a redistribution of it as affording the means of promoting research, both literary and scientific. There are many schemes which suggest themselves, and which seem likely to accomplish this object, but perhaps this is hardly the occasion to mention them.

3033. We understand that the funds applicable to fellowships might, in your opinion, be made available for scientific research?—Yes. There would be great difficulties in the way no doubt, on account of the vested interests, which would necessarily cause considerable delay in carrying out any complete system of redistribution of this fund. But still there is in this fund an immense amount of money originally intended for promoting knowledge, and perhaps for aiding teaching, which might do both. I should be very sorry indeed to see people appointed for carrying on research only. I think that they should be appointed both to prosecute researches and to teach. I believe that the teaching helps towards the research, and the research materially assists the teaching.

3034. There are a certain number of fellowships, are there not, at present given to persons eminent in science?—Yes, a certain number of fellowships have been given for proficiency in science.

3035. Has that number increased lately in Oxford?—It is only quite recently that any have been given at all. By the new statutes, colleges are now compelled to recognise all the schools in electing to fellowships.

3036. Can you tell the Commission how many fellowships are given for eminence in science?—It is difficult to distinguish for fellowship purposes between science as represented by the natural science school and mathematics, because a fellowship is often awarded for excellence in both mathematics and science. I think that I may say that not more than 10 fellows have been appointed for natural science in any form whatever.

3037. Including those that are partly mathematical?—Yes, including those that are partly mathematical, not including those that are wholly mathematical. Many colleges have their own mathematical tutors, so that there would be several mathematical fellows. I should say, however, that some are included in the number mentioned who are not fellows properly so called. A fellow receives a certain income, and is required to do no duties whatever. Of the 10 scientific fellows three are Lee's readers. They are compelled now, I believe, to reside in Oxford and teach, so that they receive the remuneration of a fellow, but they have duties to perform. They cannot go away and carry this money anywhere; so that these offices represent what fellowships ought to be rather than what they are. Then I have included myself in this list, and perhaps I may mention how I happen to be a fellow of a college. Some of the colleges have the power, by their new statutes, of electing a professor to a fellowship without any examination, and he has all the privileges, excepting that if he be a married man he has no rooms in college; but otherwise he has all the same privileges as other fellows, the only difference is that if he at any time resigns his professorship he thereby vacates his fellowship also. So that it really comes to this, that any one of these colleges may increase the stipend of any professor that it pleases, or of any number of professors that it pleases. Merton College has in this way elected me to a fellowship, so that I have the income of this in addition to my ordinary stipend. I have included this fellowship in the number of scientific fellowships which I have

R. B. Clifton,  
Esq., M.A.,  
F.R.S.

12 July 1870.



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F.R.S.

12 July 1870.

they do not, I believe, exceed 10, and to four of them duties in the University are attached. According to the calendar I find that there are 372 fellows altogether, but at the same time it must be remembered that a large portion of the whole number had been filled up many years before there was a natural science school at all, and consequently it is not possible to put that total against the number of scientific appointments.

3038. (*Professor Huxley*.) I presume that the elections to scientific fellowships would be guided by the number of persons who passed through the scientific school?—I should think that they ought to be so guided. It must be remembered, however, that a large portion of the fellowships can only be given to men, either in holy orders, or expressing their intention to become clergymen. The competition for these fellowships is not free, as only men adopting a particular profession are eligible.

3039. Can you tell us the proportion of persons going through the scientific schools every year to those who take the ordinary course of the University?—I can perhaps give you some information, although it may not be absolutely exact, that is to say, different interpretations might be put upon what I mean by different schools. I take the calendar for my guide, and simply examining the class lists for the last three years (1867–1869), I find, if the first classes only are compared, that is, the classes in which are the men who would be most likely to get fellowships, taking on the one hand the natural science school, and on the other hand the three other schools, viz., the classical school, the mathematical school, and the law and modern history school, then for every one apparently supplied by the natural science school there are 4·83 supplied by the other schools combined, so that the natural science school supplies one sixth of the whole, and the others supply the remaining five sixths. If the second classes are compared, then we have a smaller proportion of the whole, 1 in 13·75; in the case of third classes, we have a still smaller proportion, viz., 1 in 27·4. I may add that the natural science school has now a very high standard, and those who wish simply to get honours, to go through the University with a certain amount of honours, would not I think be likely to choose this school, because they would get, without perhaps the same amount of work, in some other school, a low honour—it might be got easily. I think so at all events. I know that the scientific standard is high. Then again almost every boy when he comes to the University has already had such a drilling, if he has been at a good school, in classics and some parts of mathematics, that he naturally goes on with the study of those subjects as being best prepared for them, whereas very likely he has had no instruction in science at all, and consequently it is an entirely new subject to him. These are, I think, reasons why the numbers in the natural science school are small; and then, lastly, the men who really go to into that school, as far as my experience goes, are for the most part very earnest men indeed, who intend to make some practical use of their scientific knowledge, and consider a high class as of the greatest value in their future career; this may to some extent account for the diminution, in the case of the lower classes, of the proportion of science students to others obtaining a corresponding class. If you take the first and second classes together, you will find that the numbers in the natural science school are to those in the other schools combined, as one to eight; and if the first three classes taken together are compared, the natural science school has 1 to 11·5 in the other schools combined.

3040. Then the proportion of fellowships given, having regard to the number of men who take first classes in the natural science school, is very fair?—Hardly so; but there again it would be extremely difficult to arrive at a fair conclusion, because so many of those who have taken physical honours have fellowships for mathematics, so that it is scarcely possible to separate these schools. But the way in which

ould be best indicated, remembering that there are

these difficulties, is this: by taking the number of fellows who are B.A.'s from the list, because nearly the whole of these must have graduated within the last three years, the three years to which the numbers I have mentioned refer. The number of natural science graduates in these three years elected to fellowships for natural science is three. That does not mean that there have been only three elected in these three years, but the number of graduates in the last three years that have been elected. Others may have been elected, one or two others certainly have been elected in that period, but they had taken their degrees previous to the three years in question, that is to say, they were M.A.'s when they were elected. The number of natural science graduates in the above three years elected to fellowships is three, and the number of B.A. fellows is 42, including the above three; consequently there would be one fellowship for natural science to 13 fellowships for the subjects treated in the other schools, while, as I have said, the first classes are as 1 to 4·83. I must say, however, that as far as physics is concerned I see no reason for complaint. I am not so anxious that the number of fellowships for natural science should be increased, as that the whole question of the distribution of the fellowship fund should be thoroughly reconsidered.

3041. (*Chairman*.) Are your present scientific fellows required to teach?—No; some of them are not resident.

3042. Are you of opinion that it is the business of a university to attempt purely professional instruction?—No, I think not; I think it would be impossible to attempt purely professional instruction. By purely professional instruction I mean that which consists in teaching the practical details of professions or industries; such details can only be properly learnt in establishments where the respective businesses are really carried on. The University can and ought to give the best literary and scientific training, and so make the acquisition of the knowledge of professional details easy for a student, but these details must, I believe, be learnt in actual places of business.

3043. As a place of training for the professions, do you think that the usefulness of the University might be largely increased?—Yes. The main hinderances to the usefulness of the University in this way appear to be the length of the course of study and the expense of residing in college. The latter difficulty has probably been partly removed by the admission of non-collegiate students, and both might, I think, be to a great extent removed by affiliating colleges in different parts of the country, and by allowing a portion of the necessary period of study to be passed in these colleges. Of course it would be necessary to exact some residence in the University itself, so that we might really give a portion of the instruction and form, from actual experience, an idea of what the capabilities of the men are; say one year out of three should be passed in Oxford, and two years in an affiliated college.

3044. Do you think that the last year should be passed in the University?—Yes, I think so. With the exception of one or two colleges in the country, the chances are that we should be able to supply the most extensive range of study, and the best appliances, and consequently the University would be the best place to finish at upon the whole.

3045. (*Professor Stokes*.) Was the money by which the new physical laboratory was built derived from the University chest, or from contributions from colleges or private subscriptions, or some other source?—It was derived from an ancient special bequest.

3046. You spoke of intercollegiate lectures on physics and other branches of natural science; are the lectures on those subjects in any way under the direction of the professors?—Not at all; it is merely an arrangement between the lecturers; each takes one subject or two subjects, as the case may be, which he thinks he is most likely to teach well, which he knows most about, and he takes pupils from other colleges on consideration that the lecturers of those



colleges take pupils from his in other subjects which he supposes that they know best.

3047. Would you consider it a preferable system that there should be subordinate lecturers lecturing under the direction of the professors at the University generally?—I think it would in some respects be better, but I should be sorry to see any independent person, who wished to give lectures, prevented from doing so.

3048. Do you practically find yourself that you have any time worth mentioning left for original research?—Absolutely none. I may mention that during the term in which I have had the laboratory class, in the rough way in which it has been possible before the new rooms were built, I have rarely managed to do the work which I considered necessary in less than eight hours' laboratory work a day, and I was too exhausted at the end of the day to devote myself to research. And even during the terms in which I have merely given lectures, these required so much preparation that I found very little time for doing more than answering the questions of students who called upon me.

3049. Do you not think it desirable that the professors in the various branches of natural philosophy should have a far greater amount of time at their disposal which they might devote to original research?—Certainly.

3050. How would you reconcile that with efficient teaching on their part?—I should like to see the range of subjects which each teaches more restricted. The whole of physics is now too large a subject for one man to attempt to know; he will probably only know one part thoroughly well, and of the remainder he will have a good general knowledge. If he were to restrict his teaching mainly to that one part, and to obtain the assistance of other teachers in other parts, he would gain a great deal of time for research; he would have his attention constantly directed to a single branch, and, consequently, he would become much more thoroughly acquainted with it, and the students would be always taught a subject by a man who made that subject his special study.

3051. Then in that case I presume the subordinate teachers who would be teaching other branches would be to a considerable extent independent of the professor, and not under his direction?—I think they should be somewhat under his direction, with a good deal of liberty, no doubt, but not so much that they could take their own course perfectly independent of what the professor or their colleagues wished. They must work together. The professor would have to arrange so that there should be no clashing, and so that there should be a certain unity in the teaching: as a man would have to go, upon this plan, necessarily under many different teachers in going through the whole course, it would be necessary that there should be some means of ensuring a certain amount of unity in the teaching. That to a certain extent would interfere with the absolute independence of the sub-professors, or whatever they may be called, but at the same time they might be left almost independent.

3052. Then although you consider it desirable that the professors should attend more particularly to some one branch of physics, you would not go the length of saying that you thought it desirable that the subject of physics should be split up into two or three regarded as perfectly independent branches, each with a professor of its own, and it may be an assistant teacher under him?—I should hardly go so far as that, I think. There is a great deal to be said for that plan, certainly, but at the same time I think that the different branches, although they are very distinct, yet they are so intimately connected with one another, that it is better to have one person, who professes and is supposed to have a general knowledge of the whole, to help forward the working of the other teachers according to one system. I am not sure that the other plan might not be the best, but of the two plans I should prefer to have one professor with a number of sub-professors, rather than to divide the subject among a number of absolutely independent teachers.

3053. Do you not think it desirable that more persons than the one professor should be engaged in original research?—Yes; I should think that these sub-professors would not have so much to do as to prevent them from also undertaking research. They would severally restrict themselves to their own branches, and for the same reason that the professor would have leisure, much more would they have leisure, for the professor would have, as a general rule, a quantity of routine business which they would not have.

3054. Then you would consider it important that even the subordinate professors, as I may call them, or the assistants to the professors, should not have by any means the whole of their time occupied in teaching?—Precisely so. I think also that any man who may not be engaged in teaching, but who may wish to undertake a research, should be encouraged to do so; he should have the means placed at his disposal for carrying out any research which seemed likely to the professor and sub-professor, or to some board appointed for the purpose, to be worth doing. Every help should be given to a young man in the way of supplying expensive apparatus, or rather of allowing him the use of the University cabinet, provided always that he does not interfere with the teaching. This new physical laboratory is cut up into small rooms, so that—during the vacations, for instance—a large number of men might severally have each a room, and carry on researches there when it was not wanted for teaching purposes. Some of the rooms are separated from those used for the ordinary laboratory course, so that they might be used even during term time for the purposes of research, if the number of students should not be sufficient to fill them all.

3055. You are of opinion, are you not, that the number of scientific students might be increased by the more general introduction of scientific instruction into schools?—Yes.

3056. Do you consider that boys at an early age can study with advantage such a subject as physics?—I would rather that they should study mechanics first. I do not think that physics can precede mechanics.

3057. In the preliminary instruction in schools for boys intending to come to the University, you would prefer to combine mechanics with perhaps those branches of science in which observation was more useful?—Mechanics and chemistry I should like to see combined, and I think, as far as my experience goes in Owens College, and at Oxford, that a large amount of thoroughly accurate mechanics may be taught by experimental lectures, simply taking the experiments to furnish the premisses, and then making the whole argument thoroughly logical, as logical as it would be if the subject were treated mathematically; whenever a step becomes necessary which would require, in the complete study, a more elaborate mathematical treatment, a new experiment must be performed to furnish a new premiss.

3058. (*Sir J. Kay-Shuttleworth.*) With regard to secondary schools, such as those which are about to be founded by the Endowed Schools' Commission for the cultivation of forms of modern instruction, might not the boys in them be classified in future very much according to the observation of the master as to their natural powers; as, for example, a boy having powers of observation, or a boy having powers of calculation, or a boy having linguistic powers, might be put into different courses of study, and so by natural selection the natural faculties of those boys which are most prominent might be most cultivated?—Yes; I should think that might be possible, but care must be taken not to render the instruction given in any course too one-sided.

3059. Is it not apparent from such considerations that the studies would naturally group themselves into giving a greater degree of prominence to those departments of study which depend upon observation, or upon mathematics, or upon languages?—I think

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12 July 1870.



R. B. Clifton,  
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F.R.S.

12 July 1870.

that the studies depending upon languages, upon observation, and upon mathematics respectively, are all more or less distinct; but in the case of physics, the distinction between the last two cannot be sharply drawn; it is a science of observation, but absolutely requires the application of mathematics.

3060. It is quite clear that they are not so distinct; but may it not be within your observation that there are boys who have no high mathematical power, and yet have very considerable power of observation?—Yes, there appear to be cases of that kind, but I believe they are but few, and I think that many apparent cases are only noticed in after life, when you cannot really judge whether if the mathematical power had been developed originally it might not have been very good.

3061. May it not be within your experience that a boy has been very often thoroughly dull at a school, and it has not been found possible either to improve his mind in the direction of language or mathematics, notwithstanding every effort, and yet that afterwards he may have exhibited considerable powers of observation, for example, shown a talent for botany, or some other subject of a similar kind?—I have had very little experience of boys at school, but I should say that I have never met with such a case.

3062. (Professor Stokes.) Have any cases fallen under your notice in which you have had reason to think that positive injury was done by a perpetual study of the higher branches of physics, leading the student to pass on for reasons which really were no reasons at all, or to suppose that he knew subjects respecting which his knowledge was exceedingly vague?—I am sure that a great deal of injury is done by the perpetual study of the higher branches of physics without a good foundation of mathematics and mechanics. I sometimes find that it is apparently impossible to induce persons who have studied in this manner to reason in a thoroughly logical way; they have got so into the habit of substituting fine language for logic that they never get out of the way of doing it.

3063. Where should you suppose that this positively injurious teaching is acquired?—I do not always know the antecedents of my students, and I should hardly like to answer that question without very strong evidence.

3064. Have you any evidence as to the probable motives which induced the students to study in this inexpedient manner?—I have frequently been told by those who have appeared to me to have acquired the habit I have mentioned, that they have been attending what they call science schools. I do not know what sort of schools they are, whether they are the Government schools or not, but they have expressed it in that way, that they have been attending science schools. They appear to have been taught very little mathematics, but they have obviously heard some very inferior scientific lectures, and they have probably adopted the greater part of that which was inferior in what they have heard, and very little of that which was good. A pupil is very apt, unless he is a very good one, rather to copy the eccentricities and defects than the good qualities of the teacher.

3065. (Dr. Miller.) Have you had any experience of cramming for examination?—As examiner, I have frequently had reason to think that candidates have attempted to get up something about a subject in order to pass the examination, while in reality they knew nothing whatever about it. This attempt, however, shows itself in a very different way from the undesirable habit I have mentioned.

3066. (Professor Stokes.) Then you would imagine that the result arose rather from the inferiority of teaching than from the boys attempting to study the higher branches of science at too early an age?—I can scarcely say that; the result may have arisen from either cause, or from both combined. It struck me that it was often due to their having attempted to do too much in a short time, and probably with insufficient appliances. I do not know that what I have observed

always points to the fault of the teaching; the instruction given may have been good, and I may have had a very bad caricature of it brought to me. I cannot, however, imagine that a good teacher would encourage a boy to study the higher branches of science without a good foundation having been laid.

3067. You spoke of a board for the election of the various professors. Are the members of this board, as a general rule, from the nature of the offices which they hold, conversant with the subjects concerned in the teaching of the professors whom they elect?—I should say not in many cases. Perhaps I may tell you who they are in one or two cases, and you will be able to judge better; I will take one of the oldest, the Savilian board. This board appoints to the chairs of astronomy and geometry, and the electors are the Archbishop of Canterbury, the Lord Chancellor of Great Britain, the Chancellor of the University, the Bishop of London, the Secretary of State for the Home Department, the two Chief Justices, the Chief Baron of the Exchequer, the Dean of Arches, and the Warden of New College; the Vice-Chancellor, who may or may not be a scientific man, may be taken into their counsel (he is not a member of the board).

3068. What would you consider in the abstract the best kind of body for the election of any particular professor?—I think three of the professors, whose subjects are nearest akin to that which the person to be appointed is to teach, would form a good nucleus for a board, as they should be most directly interested in the success of the man to be elected. To them might be added the Vice-Chancellor, or some person appointed by the Vice-Chancellor and Proctors, and also some person appointed by the college from which the income of the vacant professorship is partly derived. In this way I think an efficient board would be formed, but a board as good, and possibly in some respects better, might be obtained thus: to join to the persons appointed by the Vice-Chancellor and the college, as already suggested, three carefully selected persons (scientific men for a scientific chair), of whom a majority at least should be resident in the University; and to enact that when a vacancy occurred, by the death or resignation of one of these persons, the remaining members of the board, together with the professor then occupying the chair to which the board elects, should select some individual to fill the vacancy, subject to the condition of maintaining the preponderance of persons resident in the University.

3069. You would rather not have *ex-officio* members?—I think that individuals, who are well known, are more to be relied upon than persons who may happen to hold particular offices. An individual publicly selected to perform an important duty is more likely to feel the responsibility of his position than a person upon whom the duty devolves, merely because he holds a particular office.

3070. Then you would have no professors on the board *ex officio*?—No. As a matter of fact there would generally be professors on the board, constituted according to the second plan which I have suggested, but I should prefer that they should not be members of the board *ex officio*.

3071. (Dr. Miller.) How many lectures are you compelled to give?—I am compelled to give 12 lectures per term, in two terms.

3072. Then the entire devotion of your time for the sake of the students is optional on your own part?—Yes. Twelve experimental lectures, if the lectures are tolerably elaborate and cover a good deal of ground, require a large amount of time to be spent in their preparation, especially when the experiments are of a quantitative character. But at the same time, I need not devote my whole time to teaching; for instance, I might have one entire term to myself if I liked. I am compelled, besides giving the lectures I have mentioned, to give instruction once a week during one term, *sine ulla solennitate* as it is expressed in the statutes. I comply with this requirement by appointing certain hours in each week, during which



any students who call upon me may obtain such assistance as I can render in any difficulties which may have occurred to them in the study of physics.

3073. Do you give an advanced course or an elementary course, or both?—I generally have two courses. I have this general course of experimental lectures, which is not a mathematical course. In fact, I merely ask a knowledge of elementary geometry, and quite elementary algebra and arithmetic, and I avoid mathematical operations as much as possible, but I try to make the logic as perfect as possible, drawing my premisses from the experiments which I show.

3074. Do you compel the students to pass through a matriculation before attending your class?—No, there is no examination whatever.

3075. So that you do not require any mathematics?—No; if they find that they cannot follow me they can leave the class. There is no compulsion as to attending my lectures at all. Afterwards in the laboratory course, which may be considered as the advanced course, each student works separately, and the nature and extent of the work done by any individual must to some extent depend upon his mathematical knowledge. I also give sometimes a short series of lectures purely mathematical, especially when I have students who are studying optics.

3076. Those are given in the theatre, are they not?—They are sometimes given in the theatre, and sometimes in my private room. The numbers are always very small in the case of the last-mentioned lectures, on account of the previous mathematical knowledge required. I have never had any persons attending those lectures except those who are studying in the laboratory, so that they may be considered as a part of the laboratory course.

3077. What is the remuneration which you find it necessary to give to secure adequate assistance?—The demonstrator is to receive 150*l*.

3078. Have you succeeded in getting an adequate assistant for that sum?—Yes, but he happens to hold another office, he is a Lee's reader.

3079. Has it ever occurred to you whether it would be possible to connect the tenure of fellowships with teaching, as demonstrators or assistants to the professors *ex officio*?—I think there would possibly be difficulties in the working of such a plan, with fellowships as they at present exist.

3080. You seem to anticipate the necessity of a considerable staff of assistant teachers?—Yes.

3081. Do you see any way of providing the funds for that?—By the redistribution of the fellowship funds, so that probably it would really come in some measure to what you suggest. Generally the demonstrator would be a fellow of a college. The remuneration would be hardly sufficient to induce a really good man to undertake the work which he would have to undertake, unless he had some other source of income; but, as a general rule, there would be no difficulty, I think, in finding amongst the fellows some who would be willing to take such offices.

3082. Has it ever occurred to you whether it might be useful to have elections to professorships for a term of years, as in the case of the Fullerian professorship, for instance, in the Royal Institution, terminable, but not necessarily re-eligible after an interval, or re-eligible if it was found that the professor promoted the subjects of the chair?—I should not think that that would be desirable as a general plan.

3083. There would in that case be a number of persons annually elected?—Yes; but I think the teaching part of a professor's duty, at all events, is so thoroughly professional that you want to encourage a man to make it his business in life, and not to induce him to undertake it temporarily with the view ultimately of going to something else.

3084. How is the pension to be provided according to your view?—The fellowship fund I should think again would become available.

3085. Those are University professorships, are they not?—Yes.

3086. How could you touch the fellowship fund for University purposes?—As it was touched by the last commission, when the University professors were partly paid by having the income of fellowships attached to their professorships. If a fellowship were given to a professor who had done, say, 25 years' work, then the thing would be done. The fellowship would be a pension. That would be utilising the fellowships partly as pensions.

3087. (*Sir J. Kay-Shuttleworth.*) If fellowships were applied as a means of remuneration to assistant professorships, speaking of your own department, would it not be desirable that there should be some controlling body in the University by which the remuneration derived from the college and the work of the college, and the work also in the central school at the museum, could be co-ordinated together?—Yes, I think it would be very desirable that there should be some connexion between the colleges and the University as far as concerned the arrangement of the system.

3088. Have you in your own classes, or is it your intention to develop the system of the examination of young men attending those classes?—No, I have no examinations. I think the multiplication of examinations would be an evil.

3089. Have you any suggestions to make as to the encouragement which young men could derive in pursuing their studies in the department of natural philosophy by the position which they might take in the University, or the honours and emoluments that they might attain if they could be made more open to them?—I think there are no restrictions now. All are open to them, only there are not many fellowships given, and perhaps there are not very many scholarships, but still the number of scholarships has been increasing lately. I do not think there are any other sources of remuneration which could be made available.

3090. Taking into account the large amount of instruction which is likely to be given in the endowed schools throughout the country, would you think it desirable that more scholarships should be available as a reward to young men to prepare themselves in those endowed schools who desired to enter upon a course of scientific study?—Yes, that was one great object which I had in suggesting the increase of the number of scientific scholarships; it was to encourage those schools, and every other school where science is taught.

3091. (*Professor Huxley.*) Would you put your ordinary students, those that attend lectures as part of their education, simply through a course of practice in your physical laboratory, or would you reserve that for the higher class of students?—The students have to decide for themselves, I can only recommend. Their attendance upon the lectures, I think, of all professors is purely optional. The course in the physical laboratory is, however, designed for the higher class of students.

3092. But supposing you are now looking at physics as an instrument of education, I presume you think it desirable that a very large proportion of the students should go through what we may call your general course?—Yes, the lecture course.

3093. Would you contemplate putting those students through a course of laboratory practice as well?—Not the laboratory practice that I have now; if they had laboratory practice at all, a special course would have to be arranged for them. The present laboratory practice would be too long and too elaborate, I think.

3094. Respecting elementary scientific teaching in schools, I should be very glad to have your impressions, because the subject is a very important one; do you see any harm in taking children, we will say of 12 years and upwards, and giving them an account of the ordinary phenomena of nature and their relations to one another, without of course professing to give a full explanation, but merely giving as much explanation as they are competent to receive?—I see no harm in doing that, but it requires to be done with

R. B. Clifton,  
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F.R.S.

12 July 1870.



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F.R.S.  
12 July 1870.

very great care, and it requires an extremely skilled person to do it. The children must be made thoroughly to understand that the explanations are incomplete, and every effort must be made to prevent their becoming satisfied with such explanations.

3095. I am quite of that opinion, but seeing that it is done with great care, and supposing it is done in such a way as not to put any of that injurious sort of learning, of which you are justly complaining, into the minds of children, do not you think it may be of very great benefit, as, for example, surely a child may be taught by the help of a teakettle something about the evaporation of water, and precipitation, and so on, which is very definite knowledge as far as it goes, quite as definite as any knowledge can be, and is consequently useful as far as it goes, and gives the child an elementary notion of physical processes. Would you object to that kind of teaching as useless?—No, I should not at all. I think that such teaching may be very useful indeed, but I think the way in which that teaching has been given is calculated to do considerable harm, judging by the results.

3096. In such a matter as this it is exceedingly important to separate what is desirable, on the hypothesis of a good system of teaching being adopted, and that which takes place with a very imperfect or bad system of teaching; but supposing that a well-considered system of teaching, what we will call elementary physics, existed, would you have any objection to that, or think it a drawback, or would you think it a good preparation for your own more advanced plan?—Information may be given as to the main facts of science, but the extreme difficulty of giving incomplete explanations to a child, without injurious effects, would lead me to prefer that systematic instruction of that kind should be postponed until some proper foundation has been laid.

The witness withdrew.

Adjourned to Friday next at 11 o'clock.

3097. My inquiry goes to this, whether a student coming to you would be the better for having been taught the phenomena of attraction and repulsion, and such simple matters of physics as may be shown by a magnet, and whether, supposing he had been taught carefully, and had not had put into his mind a single notion beyond what he is capable of comprehending, you would think him better or less fit for your purposes if he had that knowledge?—If he has been taught nothing but what he could comprehend, I should think he would be the better for such instruction. But from experience I should prefer that a student should come to me with no knowledge of physics at all, unless he has learnt thoroughly what he professes to know. It is frequently the case that boys, and men also who have come to me, talk glibly about the laws of attraction of electrified bodies, and magnetic bodies, and so on, but have not the remotest notion of what is meant by the composition of forces. The phenomena, about which they have learnt, do not appear to have a different effect upon their minds from that which would be produced by a conjuring trick.

3098. Does not that depend upon the defect in the teaching? But supposing the teacher had told him you really know nothing about this, but here is a fact which you can understand, and you can see it and know something about it as a matter of fact, would not that be useful?—I can conceive that such teaching might be very good. However I have not come across the results of such good teaching.

3099. (*Dr. Sharpey.*) Where are the teachers employed who have been students in Oxford under the professors there?—Some are fellows and teachers in the colleges, others are teachers in our large public schools.

No. 6, Old Palace Yard, Westminster, Friday, 15th July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

JOHN PHILLIPS, Esq., M.A., F.R.S., examined.

J. Phillips,  
Esq., M.A.,  
F.R.S.  
15 July 1870.

3100. (*Chairman.*) I believe you are Professor of Geology in the University of Oxford?—Yes.

3101. And you also hold honorary degrees in Cambridge and Dublin?—Yes. I am D.C.L. of Oxford, LL.D. of Cambridge and Dublin, and keeper of the University Museum at Oxford.

3102. Are you acquainted with the public museums of natural history in this country?—With many of them.

3103. Can you give the Commission any information generally with reference to their arrangement?—I think that the condition of almost all the provincial museums is in this respect very unfavourable; that for the most part there is no definite plan according to which the museum has been arranged no specific purpose even for which it has been contemplated, but usually a great deficiency in the scientific distribution of the objects in the museum. That being the case, my impression is that of the various schemes proposed for helping them and making them more useful as teaching museums that occurs to me to be the best which I would venture to express in two or three words. Many museums

are deficient of specimens of natural history (to which I particularly wish to advert) and it has been often proposed to supplement their deficiencies by drafts of duplicates from the British Museum, which is conceived to be a storehouse, immensely rich and inexhaustible of duplicates. If that plan were followed I conceive that it would have this effect, that it would be merely transferring a troublesome heap of unarranged specimens from one great establishment to several smaller ones where still less advantage would arise from the possession of them; whereas if instead of that the British Museum could be in any manner provided with the means of sending down to all that required it, or in any case to the provincial institutions of this country, certain well-arranged typical collections which should not be intended for indefinite increase, but be made a really scientific index to the contents of the several museums, and be a basis for accurate teaching, that would be very useful indeed. At present I think it is true that you may pass through museums in different parts of this country which have been reared with very great devotion, and at much expense and with the best intentions, and yet



with the worst possible result, there being very little to be gathered of an accurate kind from those collections. This is perhaps owing to the circumstance in a great measure (and this comes to the second part of my observations), that for the most part they have been founded purely by some voluntary effort, following perhaps some sudden excitement in each of those places; and that somebody has been chosen, the best that could be got, for a small sum of money, to keep those collections in order and as far as he was able to assist in the scientific classification of them, and in many cases that is not accomplished; so that, as it appears to me, the result is this, that there is usually a museum of which the definite purpose is not clearly known, and most certainly is not clearly carried out, and it is under the charge of persons who for various reasons, sometimes a very insufficient allowance, and in other cases for other reasons, have no means of arranging the collections so that they may be made the best use of. That is my case with regard to provincial museums, but I should like to except two or three. First, I would except the museum at Ipswich, which some years ago was arranged with very great care by Professor Henslow, upon the plan that the museum should really be a teaching collection, and it was not intended to be a mixture of all things gathered from all parts of the world, but to be an arranged index, not very extensive but very well selected for the several branches of natural history. I scarcely know of any museum to which you can go where so much means of instruction in a limited occupation of time exist as at the Ipswich Museum; but that practice has not been followed, and I hardly know another instance. I might perhaps venture to except some two or three other collections, one a collection at York, which many years ago was under my own charge, but as it has passed away more than 20 years from my hands, I may venture to say something in praise of it. When that museum was founded many persons had sufficient influence to persuade the inhabitants that York would be the best place for a local museum, that the county was very rich in geological phenomena, and it was thought a fit place for a good collection of the characteristics of the county. That I am happy to say has been carried out, and I believe most of the productions of the county are completely exhibited in that place as well as could be wished, and funds were provided to pay at a reasonable rate the person having charge of it, and it has never been in fact in such a condition of disarray as the picture which I was presenting to the Commission at the commencement of my observations. Also it is requisite to except the later museums, such as that of Liverpool, and some of the older museums, like that of Bristol. Then, if I may be permitted to say so, my remedy for this is what I mentioned, namely, first that there should be sent down (for we can send them from the great national establishment surely) well-arranged typical collections, not chosen because the things are not wanted in the British Museum, but because they would be useful when they go down to the several stations. In the next place it seems to me that there is but one remedy for the imperfect classifications that are everywhere observed, and for the difficulties that everybody, even if he is an experienced keeper of a museum, has felt with regard to some particular portions of the collection; and I think that they will never be remedied unless there be in some way or other appointed a kind of travelling inspector, who should be able by his knowledge, and also by the authority that he would seem to have, to put the keepers of the various museums in relation with the great national establishment, so that there should not be one system of bad names in one county and another system of bad names in another, but that at any rate if the names were not good they should be such as would be understood and could be remedied in the British Museum. As to the grants of money, so far as I have myself an opinion upon

that matter, I do not think that money is wanted at all for those provincial museums.

3104. (*Professor Huxley.*) Do I understand you to wish to except the British Museum itself from the operation of the typical principle which you have so excellently described?—No, indeed. I must say that my feeling is much more strong with regard to the British Museum than with regard to any provincial museums, on account of the immensity of the collections, and the utter despair that almost every young student feels when he is placed face to face with that prodigious collection of objects; and a well-arranged and indexed collection at the British Museum would I think be of the very first importance, and the foundation of all measures that I myself should suggest with regard to those museums, which indeed it would be the very means of creating everywhere throughout the provinces of the country, for we should then very likely have something like an index to the true state of natural history classification.

3105. You do not think that the public taste or knowledge of natural history would be improved by being able to inspect a mile of beetles?—On the contrary, I think that the result would be very unfavourable indeed.

3106. (*Chairman.*) Do you think that Government inspection would be welcomed by the managers of the provincial museums?—I think it would be hailed really as a prodigious blessing, because of the desperate difficulty that now prevails, and it prevails even in our museum at Oxford. We are always at work there classifying the objects of natural history, but in consequence of the rapid changes of classification, and the great variety of publications in various countries, we find ourselves behindhand in several particulars, and there are specimens sent up by dozens to the British Museum, to obtain information which the officers of the museum are always most obligingly willing to give, but we have by no means always succeeded even so in getting our specimens named by the authorities of the museum. Willing and obliging as they really are, they are not exempt from some of the difficulties that we experience in the country.

3107. (*Sir J. Lubbock.*) I suppose in fact you would wish to divide the British Museum into two collections, a typical collection and a general collection; you would not, I presume, wish to get rid of the general collection?—No, indeed; that is precisely the point to which I was proposing to ask attention. I think that there are two things to be accomplished in all public museums, the one is the giving the opportunity of seeing what very many persons might otherwise never see at all—a great variety of beautiful and curious specimens of the wonders of nature; and therefore I would not propose at all to reduce the collections of the British Museum, although I might venture to suggest that after all an exhibition of perhaps one-half, one-third, or one-fourth, or a much smaller proportion would be sufficient for the object; I mean that a certain proportion of specimens might be placed in nicely glazed drawers so that you should not have such a vast area to go over. It is perfectly wearisome and fatiguing for the most energetic student to go through the British Museum. On that point there is another thing to be attended to; a museum ought to be useful to students, and you observe that the process by which you make it so gratifying to the public to look at those specimens is often the very thing which renders it impossible for the students to make any very special use of them. Suppose you take a case of birds, which so much excite public admiration, you are compelled to dress up your cases very much, and place the birds in certain pleasing attitudes, and that is all; but a student ought to have access to a collection which he could work at, so that, for instance, in a public museum, if it could be the case, that the fronts of the cases looked towards the public and the backs of the cases were turned towards the students, and the students had the means of opening the backs of the cases, so

J. Phillips,  
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15 July 1870.



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15 July 1870.

that they could take out any specimens that they wished to work at; they would not in that way much disturb the public collection, whereas at the present time, if they were to go to the front and there open the cases, of course that impedes the passage of the multitude, and in fact breaks up more or less of the arrangement. I think, that amongst the objects connected with provincial museums, and the British Museum also, it would be desirable to take into consideration two entirely distinct things, viz., an exhibition for the public, and convenience of access, with the necessary books and arrangements required for the student.

3108. You think that the method of mounting and preparing, which is desirable for the public, is often exactly that which is undesirable for the purposes of serious study?—Yes, exactly so.

3109. Have you given much attention to the general question of national aid towards the advancement of science?—Yes, I have been really obliged to do it in consequence of my very long connexion with the British Association for the Advancement of Science, and the appointment of many committees by that body for the purpose of considering questions of this kind, so that, I believe, amongst the members of that body, who have had the direction of considerable funds themselves for the advancement of science, an opinion has gradually grown up, which I think I can state pretty distinctly. It is, that the British Association, a body having funds contributed very largely by persons who are interested in the immediate prosecution of science, is very well adapted indeed for the purpose of assigning grants of money for the execution of particular trains of research, but that it is not so well adapted for the second part of the same process, namely, for the establishment of any permanent observatories or experimental institutes by which many of the researches that they do aid and do bring up to a certain stage of ripeness can be brought into a state of productiveness, so as to yield positive permanent value in science. Perhaps I might make an illustration of this by what we have really done. I think it is a very remarkable proof of the desirableness of there being some systematic help in the continuance of researches. I think this is a remarkable proof, that the British Association has kept up now for I should think somewhere about 20 years an observatory at Kew. They obtained possession of the building, and some advantages of the site, but all the expenditure has been maintained by the British Association, and by the Royal Society, so that both those bodies have concurred apparently in the conviction that it was quite requisite to add something of a permanent character for the sake of continual observation to put the researches in science to a positive proof and bring them to some useful result. That being so, I regret to say that the British Association finds itself now in the condition of being called upon to withdraw the whole of this grant, or the greater part of it, from Kew, not being able to devote 600*l.* every year, besides some accessory sums, to carry on this most useful establishment. And I am inclined to think that they may be justified in their withdrawal of the money, because a body like that is not fitted to be the founders and supporters of a continuous observatory; and generally the Government seems to be in a condition now of accepting those views to some extent; so that I believe Kew will be maintained, but it will probably be maintained in future years by the aid of Government, at least we hope so. I think, therefore, on this point that in these few words I have stated what I believe to be a very general conviction, that voluntary associations will easily perfect and in many cases set agoing the most curious and most interesting researches in science, but in order to give them a full trial and make experiments upon them on a sufficient scale, and for a sufficient length of time, something of a more permanent support is required than the voluntary gifts of such a body as the Association, or the income of such a body as the Royal Society, upon

both of which funds there are of course very many, and there ought to be very large demands. So that I am inclined to think that this is a point, with regard to which many persons will concur with me in thinking, that Government aid must somehow or other be entreated.

3110. (*Chairman.*) Is any Government aid afforded to the Kew Observatory at present?—Yes, it may be said so, but not to that part of the operations there which belongs to the British Association. There is a distinction of the two funds, and a distinction of the duties. That is pretty nearly all that may be said of the present state of the establishment.

3111. (*Dr. Miller.*) Magnetic observations are carried on there, are they not, at the expense of the British Association?—Yes.

3112. And the meteorological observations have been directly assisted by the Meteorological Committee of the Board of Trade?—Yes.

3113. (*Chairman.*) Are there other directions in which you think that Government aid could be beneficially applied?—With respect to the first part of that which I mentioned under the title of research, I think there are cases, and probably there may be more, but I should like to mention one which seems to show that if we have any public constituted body or ministry to which applications might be made without going through the Royal Society, or without going through the British Association, upon proof being given that it was a useful kind of research, I think that we might fairly ask for some further assistance. The case that I would give is this: About 20 years ago there were not 10 persons in this kingdom who knew much about the fall of rain in the British islands. At the present time there are probably not 10 members of the Royal Society who do not know a great deal about it, and that has been owing to the exertions of one or two men, especially, in the first place, Dr. Miller of Cumberland, who measured the rain on the high mountains, and afterwards Mr. J. G. Symons, who has been occupied for many years, and at much personal inconvenience, I daresay, in establishing rain gauges over the greater part of the British islands. The maintenance of them for 20, 30, 40, or 50 years or so, in order to obtain the averages of the quantities of rain, and to connect them with other variable meteorological and physical conditions is a thing which we may hope to accomplish. What we are doing now is to give Mr. Symons a very small subscription to carry on this work, and we are quite sensible that the moment Mr. Symons is struck with illness, or with advancing age, there is nobody that we know who will continue them, or give the amount of devotion to the subject that he has given with great trouble and probably with considerable expense to himself, and yet we have no means of supplementing that at present. I think that if there were a board or public minister, such as I have mentioned, before whom we could produce a fair argument for the expenditure of 100*l.* or 200*l.* a year, we might be more successful. So that I think what I have endeavoured to state is that there are two departments of scientific work requiring aid; there are some things which must go under the title of research, for which it is very difficult to obtain at present any sufficient assistance; and in the next place comes the question of the permanent trial and proof of particular scientific inquiries, so as to make them have the value which people desire them to have.

3114. (*Professor Huxley.*) Would you state your opinion as to the working of the Government grant with which you are so familiar, and whether you think that the operation of that Government Grant Committee might not be conveniently extended so as to cover the cases that you have spoken of?—I am quite of opinion, certainly, that some operation of that kind is undoubtedly the very thing which would be extremely desirable, but I am doubtful whether it is likely, that the Royal Society Council and the members that work upon that Government Grant



Committee can fairly be loaded with the, as I think, great amount of work which probably would come to make demands upon the fund if once this matter was understood to be viewed favourably by the report of such a Commission as this. At present I know it to be the case that friends of my own, who are engaged in physical research, would never think of going to the Government Grant Committee of the Royal Society unless they had some special advocate before that body, or had done something which had made them famous, and made the Royal Society have confidence in them; they would not believe that they had sufficient claim to go before that body; besides that, I ought to mention that in one or two cases to which I might refer, as for example that case of the rain, I believe the application to the Government Grant Committee of the Royal Society though not unsuccessful might have been taken up with more energy and continuity if the fund were larger.

3115. (*Dr. Miller.*) Has not the application of Mr. Symons to the Government Grant Committee been favourably entertained?—My language was intended to show that the assistance given to him was not so great as we supposed might have been given to him.

3116. Is it within your knowledge that the fact is that on several occasions grants have been made from that fund to Mr. Symons in aid of his researches?—Yes, I know that quite well, and I also know that the Government Grant Committee have on some occasions not found it in their power to grant the full amount of what was asked for by Mr. Symons, in consequence of other demands upon them, and I must, in justice to myself, mention another case in which I was officially interested, although I had no personal interest in the application. It is very well known that now for a long course of time we have been endeavouring to improve the knowledge of the surface of the moon, which was so very largely added to years ago, that is to say, 30 years ago or more, by the great German authors, Mädler and Beer. The British Association has encouraged for some years an attempt to prepare a much larger and a much better map of the moon, and we have been extremely desirous that a certain committee, which is now at work upon it, should be assisted in respect of money for this particular purpose, and I think that I must be correct in this particular, that application has been made on the part of that committee to the Government Grant Fund of the Royal Society, and I have no doubt, for the reasons mentioned before, that the fund may be insufficient, and the application has not been successfully treated.

3117. It is no doubt within your knowledge that many applications are made which the Government Grant Committee has not seen fit to assist because it has had prior claims?—Precisely so.

3118. (*Dr. Sharpey.*) Did not the Government Grant Committee supply the expense of a telescope for the object of studying the surface of the moon?—I think I have sufficient recollection of the fact to answer affirmatively, but I do not remember the particulars of the case. I have no doubt whatever that the Royal Society has given a great deal of assistance to that inquiry. The remarks that I make are merely for the purpose of showing that there still remain persons in the country who are engaged in active work, who do not derive the full assistance that they might desire from the Government Grant Fund.

3119. Keeping in view the small amount of that fund?—Yes.

3120. Is it within your knowledge that gentlemen, who are not very generally known as scientific inquirers, provided they are properly recommended to the Government Grant Committee, do receive aid when their proposed inquiries seem promising, and they appear to be competent?—Yes, and I may say, with the most entire confidence and with the greatest possible approbation, I myself have assisted, as being a member of the Government Grant Committee, to do the work in which they are engaged and which

I think is most excellent. I only regret that, from the smallness of the fund, or from insufficient knowledge which the people of the country have of the good intentions of the Royal Society, it sometimes happens, that researches of which they probably might very much approve are not presented to them at all. I am intending to trace the argument, if possible, for something of a public recognition of the importance of these things, in order that men engaged in them might be pretty sure of having a body before whom it was not only safe for them to go and ask assistance, which would be sure to be the case with the Royal Society, but that that body should have the power and consider it their duty to promote any scientific inquiry which might be for the good of the public.

3121. Do you think it would be useful if the Royal Society published more frequent reports of the expenditure of this grant, so as to make it more generally known to scientific inquirers throughout the country?—I think it would be very much so indeed, and even where there is a failure of result from some of the grants, which must occasionally happen, I do not think it would be at all hurtful to science if it was mentioned that the grant had failed, and thus some other persons might be stimulated to finish the work.

3122. Without stating the results, at any rate, the grants might be reported?—Yes.

3123. (*Professor Huxley.*) I presume, from what you have said, that you look to the existence of a minister in this country who should be empowered to recommend the expenditure of the public money upon scientific investigation?—Yes.

3124. Supposing such a ministry established I imagine from what you have said that you would not leave it to his mere discretion (he necessarily could not always be acquainted with the scientific matters) to make such recommendations, but you would appoint some sort of board to advise him?—Yes, that would be my view.

3125. Does it occur to you that any scheme could be devised by which a better board could be established than that which at present exists in the Government Grant Committee for the purpose of advising the person responsible for the expenditure of the public money?—I think that the model would undoubtedly be a very good one, excepting in this particular, that perhaps the board as at present constituted is rather a large board, some persons attending I think *ex officio*, and for other reasons. Accordingly, when you have a body so large as that summoned at not very frequent intervals, it must necessarily happen that on some occasions either a great portion of the members absent themselves, or else on some occasions some members, and on other occasions other members attend, and on that account I think not only is the feeling of responsibility a good deal weakened, but moreover the power of attention to the several requests that are made must likewise be a good deal weakened. It therefore does not occur to me to suggest a board of anything like 41 persons, but a very limited number indeed; such a number as five persons, and I think that such a board would work in many cases satisfactorily.

3126. Would not a difficulty then arise that in the public mind it would be supposed that different branches of science, which are now becoming more and more specialised and important every day, would not be held to be properly represented?—No doubt; but in that case I conceive that from a board of this kind certainly there would radiate some influences which might have material manifestations all through the country, and that recommendations would be received from the Royal Society, the British Association, the Royal Society of Edinburgh, the Royal Irish Academy, and the more obscure provincial societies, which recommendations, coming before such a body, might be sifted by some means, by some sort of inspectors or agents which the board would employ.

3127. Would not the same object be attained with

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15 July 1870.



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15 July 1870.

probably greater satisfaction to the public mind, if a larger body, such as we have been talking about (always supposing it to be properly constituted), divide itself into committees of persons having special competence with regard to each inquiry; would not that meet the difficulty?—Just so, excepting that almost all the men that I myself know, who are specially competent to advise and decide upon scientific questions presenting some novelty, are for the most part so occupied in their ordinary business of life that several of my friends in Oxford have been of opinion that it would be requisite to constitute an entirely new body of scientific representatives who should not be fastened, as many of us now are, to the continual duty of teaching, and to a great amount of labour which in point of fact would disqualify them by mere want of time enough to give their full attention to the duties of such a board.

3128. But I think nobody knows better than you, that we have seen men of science sacrifice a prodigious quantity of time to the working of scientific societies, for example, and probably it would not be a greater amount of sacrifice to enable any of us to do our duty upon a committee of the kind that we are speaking about?—Just so; and I should like to mention one thing more upon the point, what I call the most remarkable want of organisation in this country, in consequence of many of us wasting our time altogether, and even societies wasting their time in working upon problems which have been accomplished, and publishing results which are not of any value. A great many things are performed which incur a large waste of money without any good results at all, so that something of a superior organisation for the advancement of scientific inquiry appears to be very requisite.

3129. Supposing that the power of making recommendations to the House of Commons was vested in such a board and minister, would you contemplate the grant of money for the purpose of establishing physical laboratories, or places fitted for physical research; would you go so far as that in the amount of aid given to science?—No. At present, judging from such a case as that which Oxford presents to me now I am of opinion that that is at all events not the form of assistance which I for my part think is the most essential. I do not think that the granting of money for objects of that kind in general, that is to say, for the mere purpose of establishing a physical laboratory here, and another there, and so on, without some special need for it, or some special definite purpose to accomplish, is at all desirable. I cannot for my own part feel any confidence in recommending it; it is not my view.

3130. You are aware that many physical investigations require such excessive delicacy of observation that the instruments have to be supported in a particular way, and sheltered in a particular way, and so on; supposing that an investigation requiring such delicacy of observation were to be undertaken, would you advise the expenditure of money upon the building of a place adequate for such observation; for instance, in the case of the very valuable observations which you yourself have made upon the sun spots, those observations could not possibly be made without a telescope properly supported, and properly sheltered. Now, supposing you had been a young man needing help in making those observations, would you have thought it a fair thing to ask the board, which we are imagining to exist, for sufficient money to buy a large telescope to aid you in your observations?—Perfectly. According to my idea that would be a definite kind of research on which so much progress had been made as to show that it was a kind of research worthy of being prosecuted for a considerable time and with the greatest advantage. It would be therefore quite in accordance with the view which I mentioned first, to have such an observatory established; but that I think is an entirely different thing from the proposal to establish a great physical labora-

tory, fitted for all possible researches, whether we are ready for them or not.

3131. Then you would build for special research, but you would not make a building for whatever might turn up?—That is exactly my view.

3132. (*Sir J. Kay-Shuttleworth.*) You have spoken of the creation of an advising board to co-operate with the minister in giving aid to scientific research and instruction; have you thought at all of the mode in which that board should be appointed, whether by the minister, or whether it should be a board of representatives of the great republic of science among the various societies of England?—Yes; that of course leads us to the great question of the manner in which scientific appointments in general should be made. When a professor is appointed at the University of Oxford we are obliged to consider very often whether the methods which we know and use for appointment, or the methods used for appointment without our knowledge and without our control are good; and in short what method is the one which would be fittest for that purpose. The answer which I have ventured myself to give upon a subject of that kind in Oxford has been this: I was asked the other day, What do you think would be a satisfactory method of nomination to all our professorships if the present method were altered? And my answer was this, First I would have a limited number of persons on a board acknowledged to be thoroughly acquainted with the particular branch of study, and then I would have a still smaller number of persons perfectly responsible to the public for the execution of a great public duty; those two classes, and amongst the second there would be the vice-chancellor of our University, because he would consult the people there, and his decision would be as nearly as possible that of the whole body. I should venture to think that something of that kind would be the method to apply to any such board as I have myself suggested, that it should not be merely a careful selection of persons known to be eminent in science, but that it should be weighted by some other persons who are responsible to the public authorities, that is to say, to the Legislature.

3133. There are two difficulties, are there not, which are to be avoided, one that this board should have a tendency to stereotype and give the Government sanction to something which the scientific world should not approve of, and secondly, that the persons constituting the board should not have the confidence of the whole of the scientific world?—Of course a matter so new to our country would require the gravest consideration to make it beneficial. I can easily see great difficulty in the way of it, and I imagine that no step which we could take in this business would be free from difficulties; but I should hope that some independent publicly recognised board, which should have friendly relations with all the great scientific institutions of the country, would be able to perform these duties very much to their satisfaction.

3134. You would think it essential that such a board should be free from the suspicion of being so created to satisfy any political influence, and that it should be a true representation of scientific thought in England?—That is what I should desire to have, if it were possible, and I hope it is possible.

3135. (*Mr. Samuelson.*) I suppose you would wish such a board to be consultative, but that the minister should still be responsible to Parliament for all grants made upon the recommendation of such board?—Indeed I should think that would be highly desirable. The function of the board, according to my notion, would be to give aid to recommendations for really scientific investigation, which they might either make themselves or collect from various institutions in which they have confidence, and that the minister would be responsible for the final result.

3136. Then so far there would be a distinction between what you propose and the present proceeding, inasmuch as at present the minister is not responsible for the distribution of the grants which are made?—No, he is not.



3137. And you think that under such a system as that which now exists it could hardly be expected that Parliament would increase considerably the amount of the grant?—As I understand the case generally, I should think it could not be expected. I should like to make this remark, that I conceive it is almost certain that such a board as that would continue the grant which is now made to the Royal Society; that is to say, it would do what really is the case, it would request the Royal Society to be at the trouble, which is a very great one and of no possible advantage to them (not much even to the society, but nothing at all to them as individuals), of dispensing a considerable portion of the funds which might be made available. I do not myself contemplate the breaking up of any part of our present system by putting it in some way under a general national guidance.

3138. (*Dr. Miller.*) What are the functions of this board that we have been talking of; what kind of questions do you consider it would deal with?—I think, first of all, it would deal with all questions such as are now presented to the Government Grant Committee.

3139. And would it aid in directing research?—Yes. The Government Grant Committee has very limited means of maintaining anything of a permanent character, and I think therefore that this new board would recommend, in a case of that kind which we are discussing with regard to the formation of special observatories, some grant for the purpose of research requiring many years to be continued, and for which apparently it would be very difficult, or next to impossible, to find any other successful mode at present.

3140. Do you consider that any questions regarding the scientific education of the country would come under such a board?—No doubt they would; there would be, I conceive, a very natural alliance between such a great subject as that, and the definite prosecution of physical research, but I have limited my own views in the first instance to subjects connected with the teaching, experimenting, and continually observing of physical phenomena.

3141. (*Professor Stokes.*) If such a board were established and got into full work, do you not think that a large part of the time of the members of the board would be occupied in those duties?—I do, indeed.

3142. Do you think that scientific men, who have generally a good deal to do, would be willing to give up so much of their time?—I never should have thought that they would have been willing, but for the fact that I know that they do so. They now give up for the councils of many societies that meet in London an amount of time that appears to me wonderful, living in the quiet country as I do, so that I never could think of despairing as to the question of scientific men helping a board of such importance as that, when I see what pains they really do take to help, as I think, much more imperfect organisations.

3143. (*Dr. Miller.*) Do not you think it might make a considerable difference when they found that their help ended in promoting results, or that they were merely advisers, in which case their advice might not be acted upon; is not that one reason why so much time is given now that they are actually managing their own business?—Yes. I think I must still rely upon the general argument which I have ventured to use, namely, that I see my friends do actually spend such a large amount of time in the management of their own business, and that a certain portion of them might perhaps be willing, as I am sure they would be able, to direct the general government and management of a great system. I could never think of despairing when I perceive that immense quantity of voluntary exertion, very much of which I think is in point of fact labour in vain.

3144. (*Sir J. Kay-Shuttleworth.*) But seeing that the Government expend many thousands annually on such a subject as the inspection of elementary schools, would you conceive it to be an improper expenditure of the public funds that such a board should have

sufficient support in the shape of salaries to the members of that board for the advice which they might give, either on the prosecution of scientific research, or on the organisation of scientific instruction?—Certainly; my expectation has been that the occupation, if thoroughly worked, would be so engrossing that the members of the board ought to be paid exactly in the same manner as we pay examiners in the University of Oxford, and they ought to be handsomely paid, I think.

3145. And if there were attached to them inspectors of museums, and persons who might be employed in subordinate commissions, would it not be proper that some remuneration should be extended to them?—Yes, I should regard them as professionally employed to look after the arrangement of the museums, and bring them into some real relation to scientific teaching.

3146. (*Mr. Samuelson.*) As I understand, you think that the board should be remunerated for the time during which they are employed, but that they should not become exclusively public servants?—I am afraid that I have scarcely been able to think sufficiently upon some of those points so as to give an answer immediately to such a question. I imagine that their employment would be in fact continual.

3147. But seeing that it would be requisite that men of the highest position in their respective departments should be chosen for such a board, might it not be thought that, by confining their labours entirely to that matter, you might sacrifice the greater object for the less?—No doubt that would require to be guarded against. At the same time I think that we have good examples in this country. There are persons of the very highest quality, such as Sir John Herschel, who have been able to write the very best elementary books in consequence of the remarkable power which great knowledge gives over the handling of didactic treatises, and I am of opinion that such minds as those would really be very well employed at times in reviewing the state of science, and legislating, as they would in that case be in a position to do, as to its future progress. Therefore, for my own part, as it is an actual fact that Professor Airy has written treatises on astronomy, and Sir John Herschel has written treatises on physical geography and astronomy, and natural philosophy, and written them wonderfully well without stopping their other original researches, I am in hopes that it would not have an ill effect, even upon the greatest philosophers, if they were occasionally set to consult about the progress of their branches of study.

3148. (*Sir J. Kay-Shuttleworth.*) And more especially so, as one of their functions would be to be in contact with the minds which are, so to speak, at the very borders of science and occupied in matters of research?—Yes, I think so.

3149. (*Sir J. Lubbock.*) Did I understand you to express an opinion that the Government is better qualified to select the members of such a board than the Council of the Royal Society is?—No; my statement I think was, that the members of the board would have two responsibilities—in the one case they must be responsible to the scientific institutions of this country, so that these may have confidence in them, and they must be chosen from amongst persons in whom the scientific world has confidence; but I think it would require on such a board persons in such a public station that they would be immediately responsible to the Legislature; therefore there would be two elements in my board.

3150. So far as the scientific element is concerned, would not the Council of the Royal Society be as good a selecting body as could be obtained?—Yes, that would be the mode in which I should think the scientific members must be recommended.

3151. (*Dr. Sharpey.*) You are aware, are you not, that there has been now 21 years' experience of the operation of the Government grant?—Yes.

3152. With regard to the suggestion of Professor Huxley, as to the expediency of subdividing that

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15 July 1870.



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large body into committees on particular branches of science, do you think that that would not be a mode of working which would be satisfactory, supposing the Government Grant Committee were to be continued? —My view is a little different from that. My view is, that the gentlemen assembled on such a board would receive from the Government Grant Committee, or from some other popular authority, any recommendations which they might choose to send to them, and also specially they would receive recommendations from those bodies, which could not undertake themselves to make any permanent establishment, or enter upon duties which were more than those of the passing hour; and in that case such a body as that, having considered it well, they would send a report to this board, which, as a matter of course, would probably adopt it upon such good evidence.

3153. That is upon the supposition of the board that you recommend being established; but supposing that we were to revert to the existing constitution of the Government Grant Committee, and its proposed subdivision into sub-committees, do you think that that would be a judicious way of carrying on the work of the Government Grant Committee?—Of course, in trying to answer that, I must appeal to my own experience of that committee, and it would not be in favour of that process.

3154. Then, with reference to the more permanent questions to be settled in science which you referred to, and which you very properly remark the Government Grant Committee is scarcely adequate to establish arrangements for the solution of, and which are going on from year to year for a considerable time, do you not think that it would be practicable for the Government Grant Committee from time to time to make recommendations to the Government to enlarge the grant for such specific objects, and to continue it a sufficient time for such particular purposes? —Surely.

3155. And would not the case which you have referred to be met in that way?—I think that the case of the particular Government Grant Committee would be to some extent met in that way, but I do not think the general question would be completely met. I am inclined to think that the Government Grant Committee should do itself justice, and should issue all through the country a statement to the effect that funds were in their hands for the advancement of the approved branches of study. At present the impression almost everywhere is the same that I myself had, namely, that the fund is very limited, and that persons who are really not in want of assistance ought never to make application to this fund. I think it is a mistaken idea entirely, and it is very wrong, but I confess that I have shared it along with others, that we should not think of going to the Government Grant Fund unless it was really a case in which we could say, We cannot afford to continue these experiments, and you ought to give us help. I think that any person who is interested in researches, which upon good advice probably ought to be prosecuted, should not think it asking any favour whatever to go to a public department with such a statement. He might say here is a class of subjects which, if you will prosecute, you will get some good out of them. He might then be helped, or some other person might be helped, to carry out the researches. The Government Grant Committee is comparatively unknown in this country; most of the provincial institutions have not the slightest notion that they are in a condition in any way to make application to the Government Grant Committee. I am inclined to think that the public sanction to the work of that body and the grant of more money would go some way towards the accomplishment of the purposes which I have in view.

3156. It has been suggested to this Commission from other very important authorities, besides yourself, that it is desirable that the existence of this annual grant from Parliament should be made more widely known by the Royal Society, and you agree

with that opinion?—Yes. Perhaps, I may add a single remark: that in some parts of the country the impression has been that this grant of 1,000*l.* is made to the Royal Society, which, of course, we know very well is not the case; so that there is really a great mistake about it somewhere.

3157. (*Professor Huxley.*) You are probably aware that on more than one occasion the money granted by the Government has not been expended and that the balance has been returned to the Exchequer?—Yes.

3158. (*Sir J. Lubbock.*) As long as the Government confine the grant to 1,000*l.*, I presume you would not think it necessary to introduce a political element into the committee?—No.

3159. Then, in fact, you wish to enlarge the grant entrusted to the committee and to extend their influence, and with that object to strengthen the hands of the committee by direct Government recognition and Parliamentary representation?—Starting from the basis of the Government Grant Committee with the view of making it as effective as possible, that is what I would do; but I beg to revert to my proposal to have a public board so constituted as to extend far beyond the present system connected with the Royal Society to meet all cases that are likely to arise everywhere throughout the kingdom.

3160. I understand you to say that for selecting that board, there would be no better body than the Council of the Royal Society?—As a model I believe the Council of the Royal Society would be an excellent recommendatory board, and would perform its functions admirably, and there would be entire confidence in it.

3161. (*Dr. Miller.*) The board not confining their recommendations to members of the Royal Society, but extending their recommendations to all persons whom they might consider to be valuable members?—Yes.

3162. (*Chairman.*) Do you think that this grant of 1,000*l.* ought to be very considerably increased?—I feel confident that, at the present moment, it would be perhaps not desirable to grant more money to the Royal Society until it should be made manifest to the country that the Royal Society would be well backed up for the future in supporting any researches or experiments or continued observations which it might venture to recommend. I think we all want a little preparation; the country requires a great deal of local information upon this point, and after that information has been obtained I have no doubt that the grant ought to be very largely increased; it is a very small grant.

3163. You think the present grant quite insignificant, compared with what might ultimately be very well disposed of by the Government Grant Committee?—Yes; I know that we are in the habit in many provincial institutions of expending large sums, which, for voluntary and limited bodies, appear enormous, in comparison with this 1,000*l.* from the nation. Our provincial institutions are spending much money for advancement in science, so that I am persuaded that very much larger sums could be honourably and usefully spent.

3164. (*Sir J. Lubbock.*) You would in that case submit to that board, would you not, all expenditure by the Government on scientific subjects?—Yes, it is much better, I think, to have it all in one view.

3165. (*Chairman.*) When you speak of the operations of this committee being backed up, do you refer to its being backed up by a strong public opinion in its favour?—Yes; but I am thinking at the same time that it would be requisite that the Royal Society Government Grant Fund should be placed in such a position that it should be regarded as a thing to grow with the requirements of science, that the powers which it possesses should be made more publicly known, and its functions enlarged, in the sense of being something permanent. At present, being a grant from year to year, nobody would think of proposing to have a large and laborious establish-



ment upon such a basis. If it was made known, and came to be regarded as the one tribunal to have recourse to, then the scientific institutions would appeal to it with confidence, that there was a power behind the board to help them if they deserved it. That would go a great way in the direction that seems to me desirable. I think, therefore, in that sense very speedily perhaps, but not immediately, one might reasonably suppose that the grant would be very largely increased.

3166. Do you think that, as a general rule, Government assistance ought to be supplemented by contributions from voluntary sources?—I think that that very much depends upon the circumstances of the particular case. For instance, I would not wish the least in the world that any Government assistance in the matter of money should be given to any of our voluntary institutions, founded in this country for the establishment of museums, and if you think fit, laboratories or anything else. I think that people might be safely left to supply all the money that was required, if once the subjects could be made sufficiently interesting to them, so that they would regard them as matters of serious attention, which they really deserve and ought to have. I think that all attempts merely to give money would probably be of extremely small importance indeed, and that it would be much more useful to prepare the way than to merely give money, and that money should be awarded only for the purposes which I have mentioned, namely, specific researches, institutions to carry out inquiries, observatories to make long continuous observations, and so on.

3167. (*Mr. Samuelson.*) Would you extend your objection to Government grants in aid of laboratories and museums, likewise to any aid to such laboratories and museums when in connexion with elementary or secondary schools or colleges?—I think in that case, that being a purely educational object, the view that I should take would probably be different. I am inclined to think that, with regard to purely educational establishments, it would very often appear to be quite necessary that some steps should be taken by a more enlightened administration than belongs to separate voluntary associations for those purposes, so that I should answer rather differently, and I should believe that there would be great benefit from some direct and systematic assistance in the way of the construction of buildings, and in the instruction of the people that have to use them.

3168. Have you considered that question at all in detail?—Hardly. I am so placed at present in Oxford that whenever we can bring the sufficient force of sound public opinion to bear upon the University it is never a question of the willingness of the University to give us money to carry out that sort of thing. It may be a question of the state of the revenues, but we have up to this time found them generally sufficient for every purpose that we require. As an example of that I think it might be mentioned that very recently, such an opinion has the University regarding one of those branches of study, which was imperfectly furnished with rooms, and with apparatus, and with living teachers, that we have lately been enabled to build one entire capital building for the teaching of experimental physics and nothing else; it is arranged according to the plan and design of the professor, and they have furnished him with sufficient pecuniary funds and persons to help him in demonstrations, and given him grants for apparatus. In short, as far as that goes, and in respect to the University of Oxford, I confess my private opinion is, that the only thing that would be of any use to us in Oxford is the declaration in some public form or other that the subjects of physical science which we have taken so much pains of late years to introduce are subjects worthy of the best attention of the University. We are doing our best to persuade our friends of the truth of that opinion, and if once they accept the opinion as true (and really, I think, it is already accepted), I do not believe there would be any serious impediment in

the way of persons devoting themselves to the teaching of physical science, or to advance special research. Therefore I am not at all prepared to appear in the slightest degree as a petitioner for any kind of help but one, and that is merely the recognition of the value of those studies as a public and important national object.

3169. (*Professor Huxley.*) Is it not the case that the funds for the support of the assistant professor, to whom you are now referring, were only granted for one year?—Yes, it is so; but the reason of that is, that the estimate, which was formed with great care, and I had myself a share in the forming of it, was known to be of such a kind that it might be trusted for one year, but would not be a sufficient basis for a statute. When it comes to be a statute it would be a grant *in perpetuum*, and it may be a larger or a smaller grant than the professor has got now.

3170. The grant for one year did not arise out of any difficulty in the matter of funds, or any unwillingness on the part of the University?—No; it was merely that we could not give a better estimate, and it could only be trusted for one year.

3171. (*Dr. Miller.*) Did I understand that you have any objection to the endowment of chairs for the higher instruction; that is to say, the higher mathematics and branches which may be supposed to attract comparatively few students?—That is a subject which has been a good deal discussed in Oxford. My own opinion is first of all in favour of such a view generally. If it could be the case that the University could be justified in devoting a considerable portion of its funds to induce men of great eminence to come and reside, and give the benefit of their excellent presence, which is most essential, and daily and hourly intercourse with the students, they should in that case be free from any duty of lecturing except they chose to take it, which probably they would as professors, and have a fair opportunity for research. That is the view which many persons entertain. My own view is a little different. I think that the professor of chemistry, for example, should be placed in such a position that he might lecture or not exactly at his pleasure, but that he should have such assistance of other chemists of excellent quality that they should be responsible for all the several branches of chemical teaching, and then we should have a most complete system. It is not quite so now, but in some measure it approaches it. Sir Benjamin Brodie gives some lectures, and he has persons to assist him—not I think so completely as the plan which I suggest would provide—but if it were the case that the one chief professor were entrusted by the University with the direction of the teaching of one department, with adequate support by *professeurs adjoints*, as the French have it, that would very nearly meet our case. We should require the residence of all those persons, knowing that of all things which are beneficial to the students, residence on the part of the teachers, and personal communication and the opportunity of asking questions are most important.

3172. Do not you think that the necessity in many cases of making an audience impels some of the professors to lower the style of their lectures?—In Oxford, happily, there is no necessity for making an audience. In our physical science school, to which I ought to confine my remarks, certain things are essential. No pupil goes through our physical science school who is quite unacquainted with experimental physics, with chemistry, or with physiology, and he cannot be supposed to be ignorant in any one of them; but there are several other professorships which, in a certain degree, are useful in that school, but rather in the way of ornament. I must mention my own department, geology, for example. My pupils (and I am happy to say that I really have pupils) go into the physical science school, but only for honours. The University pays such great respect to geology that it will not permit any of those students to merely pass; they must come in for honours. The same is the case with mineralogy, and the same is the case

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15 July 1870.



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with botany. All those subjects can be received, and will be attended to, but they are in no manner necessary for the students; the result of which is that some subjects, which are not required in the schools, do not attract very many pupils.

3173. Does not the present system really prevent the giving of lectures of the highest class? Are there not men who would be glad to avail themselves of lectures of the highest kind who can only attend lectures of a more elementary character, in consequence of there not being provision for the delivery of such lectures?—I think that very probably it may be as you say; persons who have advanced in a certain subject, supposing mathematics, would probably, if they were to contend for the highest distinctions, find themselves under the necessity of being assisted by private teachers, and we have no special arrangements for lectures of the highest class. There is nothing to prevent such lectures being given, but there is no particular obligation that they should be given. I can hardly say that I think for my part that the lectures given are in any manner whatever affected by a consideration of the number of the audience. The persons who are appointed to teach, according to my judgment, do teach the subjects in the most complete manner that they can. I think I may venture to say that in the case of the persons who are engaged in teaching either physiology, or chemistry, or experimental physics, or mathematics, or natural philosophy, I do not think that their lectures are lowered in tone by any peculiarity of the Oxford system.

3174. Do you think that the students come sufficiently prepared to take up the highest instruction; for instance, taking speculative chemistry; would the students be able to take the highest speculative chemistry if Sir Benjamin Brodie desired to give them lectures on such subjects as we know have occupied his attention?—I think as to his best pupils the answer that he would make might be, that they would be so; but at the same time I ought to state that he has mentioned that the provision for chemical teaching is by no means complete, and we have in fact a project now before the University for a positive increase of it.

3175. (*Mr. Samuelson.*) Assuming the importance of the study of physical science, either now or hereafter, to be fully recognized at Oxford, and assuming also that your arrangements for teaching it were all that you could desire, is it or is it not the case that there is something in the social tone and condition of Oxford which would render it difficult for any considerable portion of the industrial population of the country to avail themselves of the instruction which might be obtained there; you might divide those persons into classes: in the first place, those who might be willing to go through the general University course, and, secondly, those who might wish to come up for special instruction in scientific subjects?—With respect to the first class of persons the late arrangements of the University have probably very nearly met the case by the establishment of a new body of students, not connected with any college, but coming in under arrangements made purposely for them by the University, and they come under the title of *non adscripti*. Those students have all the advantages of the other students, and it is thought by many persons that there may be occasional convenience in their not being connected with any of the colleges, but they are under supervision just as accurate as that of the colleges themselves, and there is no impediment whatever to the attendance of persons of that kind. They must place themselves, however, under our University regulations, which are very easy.

3176. How long have those regulations existed?—About 18 months. The system has practically been in tolerable work for 12 months.

3177. Can you state how far the expectations of the authorities have been fulfilled by the attendance of students of that class?—I am doubtful whether we have as yet sufficient experience to appeal to. How-

ever, I may venture to say concerning my own class, that I have several of the *non adscripti* students who do attend me. I should never have known them from the rest of the undergraduates but by their own signatures. I have them always recorded in my book, and as far as I can judge in that particular case it is quite satisfactory, but I cannot report to you with respect to the general impression in the University.

3178. Are they numerous in your classes?—No. In my class I have perhaps three or four out of some 20 or 30 names. I am now getting the fullest attendance of undergraduate members that I ever expect to have. My class contains other persons than the undergraduates, such persons as, for instance, now and then the heads of houses, and persons who have passed the condition of undergraduates, and several persons from the country, and, lastly, ladies. I found the custom of attendance upon Dr. Buckland's lectures by ladies established, and it is now continued; and amongst the ladies are a few who would pass a fairish examination. That is the condition in which I found the class, and so it is now. My room contains a good many people listening to the lecture. The persons for whom the lecture is made are the undergraduates, and those who are skilled in the subject. My lecture is not in the slightest degree altered by the presence of any other person whatever. It is given as a duty to the University, and has nothing whatever to do with the attendance of those other people.

3179. What number approximately have you of those *non adscripti* students?—The number is very small. I should think I had probably three *non adscripti* students in my last class. The total number in Oxford is not very great; it is something under 100, I should say.

3180. With respect to the second class of students to whom I referred, persons coming up for the purpose of enjoying the advantages of University teaching for special instruction, what would you say?—As far as I am aware at present the only process by which that could be accomplished would be by application to the professor. A young man in chemistry may come up from the country not connected with the University at all, and if he were to go to the professor of chemistry I have no doubt he would probably give him facilities. There is nothing in the University arrangements to prevent it.

3181. But hitherto there has been nothing to encourage or stimulate it?—No, literally nothing at all is said about it. The professor has charge of the teaching in his department, and I think I can venture to say that no case has ever occurred in which any ingenious young person has been refused facilities in any one department of physical science that we teach, but such cases are very rare.

3182. In reply to my question whether there was something in the social tone of the University antagonistic to the extension of those benefits to the industrial class, did I understand you correctly to answer yes?—No, I did not answer in that way. No doubt there is produced in the great body of students in the University a certain common feeling which itself is a power quite independent of any university statutes, or any recognized public arrangements. As far as that goes no doubt there would be some small disadvantage always in persons arriving there, and not submitting themselves to the same general discipline as the rest of the University, and they hardly could be regarded in the light of fellow-students; beyond that I do not know of anything; we have no provision for them.

3183. (*Sir J. Kay-Shuttleworth.*) You stated that you thought it would be a great advantage to increase the tutorial assistance of the several scientific classes in the University, and that Professor Brodie had obtained some such assistance, but would desire considerably to augment it both for the objects of professional teaching, and likewise to leave the professor himself greater time for research?—The latter part of it is my own particular gloss upon it,



and I particularly entreat attention to that part of it, namely, that the person who is entrusted by the University with the direction of a great subject of study should be left sufficiently at liberty to prosecute the highest form of research in that branch of knowledge, having for the teaching of it responsible and very competent assistants, who might be called assistant professors, or in any other way so that he might be left to exercise his mind in the fullest manner that he could use it, both for the benefit of the teaching and for the advancement of knowledge. I think that would be a most desirable object, and in fact it is to some small extent really attained in the present condition of things, but not enough.

3184. Can you offer to the Commission any suggestion of the means which may have occurred to your own mind by which either the University or the colleges could provide such assistants to the respective professors of science?—Supposing the funds of the University to remain prosperous I can conceive of nothing so satisfactory as our present system, and I am convinced that, if they should remain prosperous, the growing influence of the physical science teaching in Oxford will be enough to obtain from the University all the assistance that it wants, but I am not able to answer for the funds of the University, and there is some danger perhaps that they may approach so near to a balance that they may have nothing more to give for any particular teaching. Of course with respect to the colleges there are funds, and those funds were a little tried by the Commission when they came down to Oxford. I am not able to give any opinion as to the fund which might be obtained, excepting from the general chest of the University, for the augmentation of the teaching power in our several departments. I only wish to express my own opinion that the University would not be unwilling to give assistance whenever it can be shown to them that the success of the teaching depends upon their giving that assistance.

3185. Taking into account the very favourable disposition to increase the tutorial power, on the part of the University, may I ask, whether the scientific professors and their departments are represented in that governing body and to what extent?—Yes, they are represented in the council, and in the bodies which have to decide on questions of finance. All resident masters of arts attend congregation and convocation as a matter of right.

3186. So that they do constitute a prominent part of the governing body?—Yes, certainly.

3187. (*Chairman.*) But simply as masters of arts?—Yes, simply as masters of arts and as professors they are elected to the council. The constitution of the council requires that some of the members should be professors.

3188. (*Sir J. Kay-Shuttleworth.*) Is that in virtue of their office, or does it simply arise from personal respect and deference to their status in the University?—They are all elected, but there must be so many professors elected, and so many heads of houses, masters of arts, and so on.

3189. Is the separate faculty, as a faculty, represented in the council?—Not in a separate form, nor, indeed, is there any separate representation of any kind in the council; it is merely a gathering of all classes in the University, heads of houses, professors, and so on.

3190. You have expressed a very gratifying confidence in the growth of opinion in the University, and in the great readiness of the governing body to afford aid to science. Might I ask whether or not that is likely to operate to procure some co-ordination of effort from the funds of the colleges towards such objects as those to which I previously adverted, in providing tutorial assistance for the professors in their respective departments?—On that point I am doubtful whether the reply which I make will appear to you of much value, but nevertheless I have reflected upon it, and what I observe is of this kind, that the colleges are sufficiently penetrated (speaking of several of them) with the opinion

that it is very desirable in their teaching to encourage the growth of physical science; in consequence of which several colleges are teaching physical science within their own walls. Magdalen College, for instance, to which I belong, has a very considerable amount of teaching in physical science. It has a laboratory and considerable means of teaching, and does teach; and it appears to me that the same thing is more largely carried out in Christ Church, and I am convinced that many colleges will actually introduce the physical science teaching, and probably with a good deal of success, not intending to rival, probably, in the end, the teaching which the University appoints, but in preparing persons to come to the University teaching. So that I do not think that the classes which are directed by the professors will be at all diminished by the growth of this kind of teaching in the colleges, but it makes me hesitate to believe that with that tendency to make their own special schools suitable for their own members, the several colleges will be easily induced to contribute any very considerable sum of money towards the University chest for the payment of assistant professors.

3191. Have you considered at all whether it may be desirable to adopt any measures, and, if so, what measures, to secure harmony of action between the teaching of science in the colleges and the teaching of science by the professors in their respective departments connected with the museum?—Hardly. To say the truth, I do not myself feel the want of any provision at all. The fact is, the persons who are engaged in teaching physical science in Oxford do it with so much of a common effort, and have so many means of attaching themselves one to the other, that I do not at present admit that there is any kind of necessary rivalry at all between the teaching which is useful in a college and the teaching in the museum, which is useful to the whole University. I believe that the more teaching we can get of a private kind, and limited, perhaps, as to degree in the colleges, the better it will be for the public teaching directed by the University.

3192. Taking your own department, or that of Professor Brodie, or that of Professor Rolleston, supposing that the assistants in your classes were also tutors in colleges, would not that probably secure, even in the remote future, considerable harmony of action?—Possibly. Everything of that kind, I believe, would adjust itself; and if I might venture upon a sentiment which will perhaps surprise some of the members of this Commission, I really have a private opinion that it would be far better to let the present rather favourable tendency with regard to physical science in Oxford grow by its natural strength, and by the force of some general experience as to the importance of this branch of knowledge, than by an attempt to introduce any particular modes or rules by which it is to be advanced. My impression is that we know very well how to advance it if only we can have the opportunity, and the opportunity rests with three things, I think; there are first the men to be taught, and all the great schools are gradually introducing notions, and pretty accurate ones too, of physical science, so that it may be hoped the men will come up better prepared. Then, in the next place, of course we must have proper teaching; and I am convinced that the University will help us if only we can show that our teaching has good results. But the thing of all others the most important is the conviction to be somehow or other pressed into the minds, not of the University only, but of the community at large, that physical science deserves to be attended to. I am persuaded that that is not yet sufficiently the opinion of the country at large.

3193. Could you say how many scholarships there are at present open to competition, and principally to be obtained by acquaintance with science?—I am afraid I can hardly give you the accurate number. There are some in Magdalen, there are some in Merton, and there are some in Christchurch, and I think there

J. Phillips,  
Esq., M.A.,  
F.R.S.

15 July 1870.



J. Phillips,  
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F.R.S.

15 July 1870.

are scholarships in several colleges; it is a growing feeling I may venture to say.

3194. Have those scholarships been subject to much competition?—Yes, I myself have examined on several occasions in respect of Magdalen, and on some other occasions in respect of some of the other colleges. The competition in some cases in Magdalen has amounted I think to six, or, perhaps, eight persons for one scholarship in physical science, and I am persuaded there would be more, provided its advantages were made more generally known; but we do not take much pains to make them very generally known. They are printed in the Oxford Calendar, and they are known more or less by circulation amongst the great schools, but I confess that I think the advantages which the University of Oxford really does offer for persons coming up to commence their studies are not sufficiently known.

3195. You are probably aware that the Endowed Schools' Commission intend to divert local endowments to the foundation of first grade modern schools?—Yes.

3196. And that great hesitation is felt on the part of certain of the trustees of those schools, and especially of the masters, as to the proper balance of rewards between literary and scientific distinctions in the two universities, and that the preponderance of rewards for literary acquirements is a considerable hindrance to the adoption of the recommendations of the Commission?—I have no doubt that that is exactly as you state; at this present moment no doubt it is so.

3197. For the promotion, therefore, of scientific instruction in the endowed schools of England, and the appropriation of a considerable portion of those endowments to scientific instruction, may it not be important that not only what has already been accomplished in Oxford should be much more widely known, but that more scholarships should be open to the competition of properly prepared science students?—Yes, I should venture to answer that question affirmatively; I think it would be a great advantage. At the same time I feel, with respect to all those questions, the necessity of the concurrence of circumstances. If we were at this time to be furnished with many additional scholarships for physical science in Oxford I am obliged to say that I doubt at least whether the state of preliminary instruction which should bring good candidates to our scholarships has had time to make itself quite satisfactory. Several of the public schools have taken up these subjects, and have appointed masters in science, and we know very well that they are persons deserving great confidence, but they have had only a very short time to work; and I am inclined to think that this will happen, that when they are able to send up good scholars there will be a considerable inducement to provide scholarships; and I am almost of opinion that an abundance of good scholars would necessarily produce a sufficient supply of scholarships; but I am not quite sure that the contrary would be true till you have given time for the present system to unfold itself. If you were to constitute scholarships to-morrow it appears to me very probable that many candidates would come, none of whom would be worthy of being accepted.

3198. But let me suppose a professional man of a limited income living in the country, and having to select a place of education for his son, and that there might be near him an endowed school with purely literary and mathematical instruction, but with no instruction in experimental science; and that there might be near him another endowed school, with instruction in modern languages, a good laboratory, and good means of obtaining at all events a sound preliminary instruction in experimental science; and that the father, not having the means to secure instruction in the University for his son, unless his son were successful in obtaining a scholarship, might be led to prefer the endowed school in which purely literary instruction was given, on account of those facilities, rather than the scientific school which did not afford those ad-

vantages; is it not obvious that the existence of the scholarship has a powerful influence upon that class of deserving men in seeking a school for their children?—No doubt. It appears to me that the existence of scholarships has an influence upon schools, and in the next step of course it must have its influence upon the intelligent persons who confide their children to the schools: but I think that the first influence would be upon the schools. The masters would train for the scholarships which were accessible.

3199. Your previous answer had reference to the obvious necessity of the adjustment which must occur between the local instruction given in such schools and the curriculum of the University, and likewise all the honours connected with that curriculum, and you rely greatly upon the power of public opinion for accomplishing both objects co-ordinately, and probably nearly simultaneously?—I very much rely upon the gradual growth and the improved condition of feeling and understanding with respect to the real advantage of physical science, and I know that it is daily advancing.

3200. (Chairman.) You stated, did you not, that there was no pass examination in geology?—There is no special examination in geology.

3201. Does that apply to the whole of the natural science school in Oxford?—No, it does not apply to the proper physical science school.

3202. Is there a distinction between the natural science school and the physical science school?—It is the same school. It has three fundamental parts—the experimental philosophy, the chemistry, and the physiology; those are the three foundations of the school, and we hope, whatever success may attend the other departments, that those three will be gradually so well supported by the University that nothing at all can be said in respect of a complaint of the inattention of the University to those schools. Then with respect to some other branches of study, for instance, geology, it is regulated in this way: a person who is a good physiologist is likely for that reason to be a much better student in the part of geology which we call palæontology than he would otherwise be, and we naturally desire that he should be a person acquainted with that subject. Consequently geology could not be taken in well by itself as a branch of study on account of the incompleteness which it might be supposed would remain in the mind of the student who should merely take in what he called geology; and the same applies to mineralogy, and the same applies to botany. Each of those subjects is so far encouraged that each of them has weight for obtaining of honours, that is, for getting a class; if the person who takes them in is well grounded in the general basis of the school (that is our present position), there is no impediment whatever for the cultivation of those branches of knowledge; but the success of the school is made to depend upon what are thought to be more fundamental and more essential, so that a person does not go through that school without some considerable information about experimental physics, chemistry, and physiology. We regard palæontology, for example, as a kind of applied science, and we regard zoology and botany much in the same way; that no person can really be a good botanist, or zoologist, or a good geologist, unless he is tolerably well grounded in the fundamental parts of the school. That, I think, is the true doctrine of our school at present.

3203. I understand you that a student can obtain his degree in the physical science school?—Yes.

3204. But he undergoes no examination whatever in geology?—Not necessarily in geology, or mineralogy, or zoology, or botany; he undergoes no examination in those, unless he chooses.

3205. You have some acquaintance, have you not, with the subject of field clubs, and other local institutions of that character?—Yes. All through this country now the local interest, in natural history at least, is really so much diffused that almost in every district where there is any good botany, or any good



mineralogy, or any good geology, there is sure to be a field club, which is limited in point of extent perhaps to a county or to some natural district. Of these there are many, and they are very active, and in some cases they are really doing a good work in spreading considerable knowledge of natural history in a given district. A point which I wish to call attention to is the extreme imperfection of our system of publishing scientific notices of all kinds whatever; even for the most thoughtful researches in this country it is quite a matter of uncertainty whether you will find a record of the work. It is a great pity, and I think one of the misfortunes of this country, that there should be any other publication of those notices but one. There was a time when the Royal Society's proceedings and transactions contained all the notices which were important in the country, and no doubt it would be very difficult to restore that, but surely it would be far better to make some effort to collect a number of really the best publications that are issued every month in all parts of the country. We cannot tell what to do with them. They often contain very valuable results which are likely to be neglected; people take them and throw them into the waste-paper basket, and a great deal of work is utterly lost. I believe among the functions that we should expect of an intelligent board devoted in any manner to the advancement of science might be that some recommendations would be put forth with authority, which should enable us to look for chemical papers in a

The witness withdrew.

GEORGE ROLLESTON, Esq., M.D., F.R.S., examined.

3210. (*Chairman.*) I believe you are Linacre professor of physiology in the University of Oxford?—Yes.

3211. What is the meaning of the term physiology as used in the ordinances relative to this chair?—It is about equivalent to the use of the word biology as ordinarily employed now, and comprehends both physiology proper and morphology; you can see it by reference to the terms of the establishment of the Linacre professorship, because underneath the Linacre professorship is now comprised the Aldrichian and the Tomlinsonian professorships of anatomy; and in the later statutes it is distinctly said that the Linacre professor is to be at the same time the Tomlinsonian and the Aldrichian professor, that is to say, the word physiology is employed in our later statutes as comprehending both physiology proper and a knowledge of structural anatomy, or morphology, so that that word, physiology, is to be taken as equivalent to biology as used in its widest modern sense.

3212. At what time was this professorship established?—It was founded by an ordinance made in relation to Merton College by the Oxford University Commission, of the date of the 3rd of April 1857. This ordinance was approved by Her Majesty in Council in 1858, and I was appointed in 1860 the first professor on that foundation.

3213. What are the means and resources attached to this professorship?—Four fellowships of Merton College have been set aside for the support of the professorship proper, and in addition there is the Aldrichian and Tomlinsonian professorships of anatomy, of which I have already spoken; but those professorships have the support of a demonstrator to be paid for out of them. Those are the means and resources. At my appointment those were not all available. The Aldrichian and Tomlinsonian professorships were; but the funds from Merton College were not all available in the year 1860, and in 1863 the University allowed me a demonstrator until such time as all the funds should be forthcoming and available for the purposes of the chair.

3214. May I ask what the total emolument of the professorship is at present from the endowment?—From the endowment of Merton College the salary is 800*l.* a year, and the other professorships something

book devoted to chemistry, and that we should be able to look for researches which we generally value in some publication where we might reasonably expect to find them. As it is at present I cannot conceive of anything so distressing and productive of such waste of time as this want of method which we are at present suffering from.

3206. (*Dr. Sharpey.*) You would aid these publications, would you not?—Yes, I would somehow or other try to discover a method of aiding them by direction and grants of money, by which they should be organized and put into some useful form, so that what is good in them might not be quite lost.

3207. Nobody knows better than you that some of those valuable papers require expensive illustrations, coloured figures and the like, which are rather beyond the resources of small societies, or even of large societies, where there are many of them?—Yes.

3208. And that might very advantageously be aided, might it not, by public money?—Yes, I think so, indeed.

3209. (*Mr. Samuelson.*) Would you not be afraid of a claim being put in by the purveyors of political intelligence for aid on the same principle?—No doubt it would be subject to some difficulties, but if it were once in the power of persons who were really interested in a better method of recording our progress in science, and would give themselves some trouble about it, we should by degrees get into some better system. It is a dreadful waste of labour, money, and time, at present.

about 200*l.*, sometimes a little more and sometimes a little less; but the whole 200*l.* is paid to the demonstrator.

3215. With respect to work-rooms, what means are provided for you?—I have brought here a plan which will show my part of the museum by comparison with the plan of the whole, which I have been informed has been laid before you. It has a scale (*handing in the same*). I may just explain that this plan represents two stories, but it is only the ground floor that you see. I have two floors, and the upper floor is slightly different in arrangement from the other.

3216. Is the plan put in by Dr. Acland the other day that to which you refer?—Yes.

3217. Have you adequate accommodation both for lecture room and also for the display of your collections?—Yes, I have very ample room for the display of my collections in the court of the museum. There is in the plan which I have put in a part of the museum court; it is something like two-fifths of the entire museum court, a very large open space, and that is assigned to the display of the collection of comparative anatomy and ethnology.

3218. What is the present number of students?—I have taken the average of my attendance for the last three years, that is the last nine terms, as we have three terms in a year, and 37 has been the average for the last nine terms.

3219. Do the students as a usual rule attend in several successive years?—Yes. On going over this matter, and taking the average, I find that I have a pupil who is working at this present moment even in the vacation time in the museum, who has been in attendance for three years; that would be three academical years. I think he began in the October term, and we are now in July.

3220. Do the University regulations prescribe any course of study for students in the department of anatomy and physiology?—The University regulations, by necessitating that a man does pass through two examinations, one the examination known as "responsions," and formerly as the "little go" in ordinary language, and the second known as "moderations," do prescribe a certain amount of previous study practically; for a person cannot with advantage work the two lines of literary and scientific work

J. Phillips,  
Esq., M.A.,  
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15 July 1870.

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15 July 1870.

in my opinion, at least according to the advice that I give, except in rare cases, simultaneously.

3221. Any student entering upon your courses must have gone through a certain amount of literary education previously?—Practically he must have, because I say to the students always, with the exception of the non-University part of my class, that unless they can pass their moderations and responsions, without running the risk of being plucked in the examination for them, it is better that they should give themselves entirely to preparing for them. According to the present legislation, on which I shall have to say something further, they can get rid of them pretty nearly in a year, though not quite, that is to say, in their fifth term. My advice is that they had better not come till they have got rid of their examinations, unless they have already had an amount of classical and mathematical acquirements which does enable them to count upon passing them without a chance of rejection, rejection not being an evil in itself so much from this point of view as that it delays their having an undivided attention for their study of science.

3222. Are you required to deliver a certain number of lectures?—No, I have no regulations laid down for me at present, except that I reside six months in the year. I was the first professor upon this foundation, and I believe that the University has a right to legislate anything that it chooses for me; but though it took that precaution, or power, it has not laid down any restriction whatever with reference to myself, who was the first professor, except that I reside during six months in the year, those six months being between the 1st of October and the 1st of July.

3223. As a matter of fact, you do deliver courses of lectures?—Yes, a considerable number.

3224. (*Professor Huxley.*) Supposing that you were so unconscientious as not to think fit to give any lectures at all, would the University intervene?—I really do not know whether it would or would not; if we look to what the University did in former times, in the evidence which Sir William Hamilton got together, you will observe that the University in former times was very lax in its requirements; whether it would be so now I do not know; I think perhaps not.

3225. It has the power, if it choose, of obliging you to do what it ordered, or to give up your post?—Quite so; the words of the statute contemplate the chance of a person being found to be "*insigniter negligens*."

3226. On the other hand, can the University really prescribe for you any number of lectures it chooses that you should give?—I believe that I am bound to conform myself to what the University may see fit to legislate with reference to me. I took the professorship upon those terms, so that if they were to lay down any number of lectures, say one per diem for the 365 days in the year, I believe that according to the statute I should be obliged to do it; at present they have not done anything in the way of prescribing the number of lectures.

3227. (*Chairman.*) Will you state to the Commission what courses of lectures you give?—I have in two terms of the year two courses of lectures in each term, one upon physiology proper, and one upon anatomy, going on simultaneously, and I give then three set lectures in the course of the week; but in another term, which is the summer term, what I do is this, I give only one course of lectures, and I give a larger number of demonstrations. I lay more weight and put more value upon the courses of instruction which take the shape of demonstrations than I do to the courses of instruction which take the form of lectures; indeed without demonstration, courses of lectures are of very little use at all in my subject. At present I do not at all insist, but I indeed rather discourage young men from coming to my set lectures until they have had one term's work at least in the way of demonstrations, so that they get acquainted with the actual natural objects before they come to me, and have to deal with general propositions which such lectures necessarily consist of. Besides the demonstra-

tions I set my students work in another way, that is to say, if they choose to do it, for I have no compulsory power entrusted to me, neither do I wish to have any compulsory power, but I have a number of students who bring me answers to questions, and those answers to questions I look over, and also for those students who will bring me their notes of my public lectures, I look over their notes. That I believe is a very useful thing; at all events it is as useful as anything else that I do.

3228. Do a good many of your students avail themselves of the opportunity that you afford them of bringing their notes and answers to be looked over?—Yes, a very considerable number; especially those who are going to be examined. I would say that I do not take the examination myself if any one else can be found for it. Indeed I think it much better that a person who is a professor should not *ex necessitate* be an examiner.

3229. Do you think the preparation for entering upon this course all that is to be desired?—I do not at all, because no real preparation does actually exist; in many cases it is actually nil; many persons come without having any sort of preparation at all for the study of natural science. I ask them what reason they have for thinking that they have a call for natural science, and they tell me that they do feel that they have a call sometimes; and in many cases I may say that this is so, but in some I do not find that they have any very distinct reason for taking up the subject.

3230. We have heard that some of the colleges have established a certain amount of instruction in physical science; have any of the students who come to you previously passed through the course of instruction which the colleges provide?—Yes, some have from the colleges which have done that. I think it has often been the case that the young men who come to the museum have felt the want of the tutorial element when they have come thither. For the colleges have for a very long time had an organized system of instruction in other subjects, and a student who comes to the museum feels it to be an injustice that he should be obliged, at the college, to pay his tutorial fees, without getting tuition for it there. To meet this, the colleges have in many cases acted thus: when a student has declared for natural science, either they have paid him back part of his tuition money where-with he has been able to pay his fees at the museum, or they have furnished him with tuition themselves, as at Magdalen and elsewhere. On the other hand, many students owe their first introduction to natural science to the systems of instruction set on foot in the colleges, and come to the museum subsequently.

3231. Have you any recommendation to make for providing the students who come to you with a better preliminary instruction?—I think that at the schools, just as at the universities, the value of science, as an agent for education, ought to be recognized. My own private opinion would be that in all schools there should be a bifurcation by which boys with a special call should have that special call recognized, and have that particular talent *exploité* or trained to the best purposes in the interests of the nation, and their own as well. I am not in favour of diminishing at all the quantity of literary culture which at present is demanded; but upon that I think some remarks will come further on, according to the *précis*.

3232. Do you think that the University allots a sufficient amount of honours and rewards for the study of natural science?—That is a somewhat complex question. I do not think it does; but I do not, on the other hand, think that it is reluctant to do so. The natural sciences have only comparatively recently found their way into our curriculum, and cause and effect, as I say elsewhere under another head, change their places a little in this matter. If men of ambition understand in coming to the University that there is only a certain per-centage of reward for natural science, men of ambition, which is a more or less convertible appellation for men of talents, take their talents to the best market, so that what is in



the first place a cause subsequently becomes a consequence, and the colleges may feel themselves justified in saying, We have not any very large number of natural science students, who are equal to those persons who have gone through our older curricula with success, and therefore we are justified in not giving fellowships for it. Referring to fellowships, it is a little difficult to disentangle the matter, but the way which I should suggest, as being one more or less calculated to meet that difficulty, is this plan; that when a person has got honours in any one subject, after that he should be allowed to compete for honours in any other. I would put the words as widely as possible, but of course I speak in the interests of that subject in which I am interested. At Cambridge, I believe that a person who has passed in honours in the mathematical tripos has then a year's further time allowed him to compete in any other tripos that he chooses; but whether that be so or not, I should be glad to see a plan of that kind at Oxford, and the way that it would work would be this; a person who had got honours in either of the older curricula of mathematics or classics might see it to be worth his while to go into the natural science tripos, and then by getting honours in that he would act as a sort of missionary and an advertisement of the real value of such instruction, and I believe that young men living and working amongst young men are the most efficient educators of young men up to that level of public opinion without which I apprehend no artificial legislation is permanent. If young men saw a person of whom they had been able to take the measure, if I may speak a little vulgarly, in the subject of classics, giving up his attention to natural science, or to any other subject of that kind which may be called a secondary one, they then would have their eyes upon that subject, and when such a person got a fellowship he would act certainly as an advocate of the value and merit of natural science.

3233. Do the University regulations at present preclude a young man who has obtained honours in mathematics or in classics from obtaining honours in natural science?—By no means. There are several fellowships now possessed, I am happy to say, by persons who have gained honours in natural science, and who have got those other honours also, but as the University regulations stand at present, no honour in any school is obtainable after 18 terms, that is to say, after four years and two terms, our year having four terms; consequently, considering how severe the competition is for getting honours, a man is tempted to postpone going into either of those primary schools as long as possible, and hence has no time left for preparation for other honours. It is clear that there is a disadvantage in my plan (but in most human arrangements there are disadvantages as well as advantages), and that by prolonging the curriculum we come a little heavily upon the parents' purses, but I do think, on balancing the advantages and disadvantages, that this plan which I have often advocated has the advantages preponderating.

3234. Can you tell us the value you assign to the Oxford plan of studying natural sciences as a preparation for the various careers in life?—I think that it certainly does fit people to deal with a very large number, though by no means with all the large problems that a man has to deal with in whatever sphere of life he is thrown into. I would mention such matters as estimating the effect of climate and adopting sanitarian methods, and the value of particular lines of treatment, and knowing whether a thing is proved in such a subject as medicine, or whether it is not proved. All that, I think, is a thing which natural science teaching does confer upon a man, but a purely classical and moral science training, which does enable him to deal with other classes of evidence than the scientific, does not confer upon him the power of estimating the value of evidence brought forward in such cases as those which I have just mentioned.

3235. Have you had any means of tracing what

has become of some of your earliest students?—Yes, of a considerable number of them. Some have gone into medicine. I have I suppose now, out of a class I think this term of 33, eight or nine who are going to be either physicians or surgeons, not more. Others have gone into orders, a few are lawyers, and others are merchants, and some are in the Indian service or in the colonies.

3236. About one-third of them have gone into the medical profession?—I think scarcely one-third, say about one fourth.

3237. (*Mr. Samuelson.*) Have any of them become eminent merchants or manufacturers?—I think that it is so short a time since we began this system, that they have scarcely had time to do so. Some are certainly very fairly successful in the line of life that they have gone into. I can mention as physicians, Professor Corfield, in University College, Dr. Church, who is physician to St. Bartholomew's, Dr. Payne, at St. Mary's Hospital, who were members of some of my classes for some time. The same may be said of Messrs. Galton, Wm. Boyd Dawkins, and E. Ray Lankester who have all written original papers on subjects connected with comparative anatomy.

3238. (*Chairman.*) You are prepared, are you not, to offer to the Commission some suggestions; first, with respect to increasing the teaching power of the University in those departments of knowledge?—Yes. I do think that we have scarcely enough persons to teach. For my own subject, to which, perhaps, I had better confine myself, I do not think that if you have less than one teacher, in the way of a *rappéteur* or demonstrator, as we call it in English, 16 persons are about the outside that can be managed; I mean 16 on the plan of each of those persons working only three days a week; for I believe that eight persons, if they are to be taught this subject properly, are as many as a demonstrator can manage at one time. I have at present two demonstrators, and they have certainly as much to do as they can manage. At present I have just got as much teaching power as can keep them properly looked to if the number is not increased, but if it is increased I should want more teaching power upon that estimate. In my subject, I think that 16 persons or eight persons per diem is the maximum which one demonstrator should be charged with looking after, if they are to be properly looked after and properly taught. In the interest of the subject I would say that I certainly do think that anatomy and physiology is too large a realm to be entrusted to one person, if he is to manage it as it should be managed. Certainly, if anatomy is to take anything like the development which it should have in Oxford, to cover the area, and that you can perceive by looking at the plans it does cover, it will and does require a very considerable amount of time to keep a museum, which is to answer such needs, in order. The number of specimens which a museum contains is a good gauge of the time which has to be expended in caring for it. To do this well is as much nearly as a single person of skill and intelligence should be expected to do. Again, the amount of relations to be maintained with outside people, either personally or by letter, is a very great call upon the time of a person who is charged, as professor of anatomy, with a large museum such as he must have in such a position as that. Secondly, I think that the two subjects, anatomy and physiology, which, in answer to your first question, I said were both classed under the word physiology, are in themselves and irrespectively of the material appliances they imply and demand so large, that two persons at least ought to be told off for undertaking them, in order to keep them at all abreast of the level to which they have attained in the outside world.

3239. (*Dr. Miller.*) Do you take descriptive anatomy as well?—I have upon several occasions; on these occasions I have taken human anatomy and taught it, comprising in my teaching, all that is given in the manuals used in the medical schools to the best of my ability. But I am not quite clear that that is

G. Rolleston,  
Esq., M.D.,  
F.R.S.

15 July 1870.



G. Rolleston,  
Esq., M.D.,  
F.R.S.

15 July 1870.

altogether an advisable thing to be done in Oxford, excepting occasionally as occasion should arise. I should do it again if I saw that I could benefit a sufficiently large class of young men who were going into the medical profession.

3240. (*Chairman.*) Will you favour the Commission with your opinion with regard to the increase of teaching powers in the interest of the subject?—I think that a person who is interested in two such very large subjects as these must necessarily fall back from the level to which those subjects have attained in these days from the rapid intercommunication now possible in the world. In the time of Haller, and even later still, these subjects had nothing like the development that they have now attained. That can be seen from the purely literary side, by looking at the periodicals and books published now; such works, for example, as the Munich "Zeitschrift" for pure physiology, and the Wurtzburg "Zeitschrift" for scientific zoology. The extent of ground which they cover is very great. The different sentences which I have written in my *précis* under head viii. A. 2, as to the reconciliation of the antagonism between the interests of teaching and those of learning or research, embody what I think bears upon the interests of the subject. The accepting of the principle of the advisability of creating chairs for men as well as of creating men for chairs, I think of considerable importance. Then I would say that if you do increase the teachers you certainly ought to take very great care how those teachers are appointed. What you want to increase is to increase something which is good, but if you do not take means for electing them properly you will not do very much good by that, so that I think that one of the cardinal points is really that a good plan should be adopted for choosing teachers and professors.

3241. (*Professor Huxley.*) What antagonism between the interests of teaching and those of learning or research do you contemplate?—I think that if a person has a very large number of lectures laid upon him he will find that the teaching does overlay the learning, and the more you increase the rewards for learning that are given to students the more *exigeant* will you find that those young persons are of the assistance of professors. And upon this I would just say that we do reconcile, at least I hope we may be able perhaps in the time of my successor, the teaching and the learning by means of our long vacation which does enable us to improve ourselves somewhat; for in the term time undoubtedly there is scarcely any time for anything but looking after the management of the classes, the examinations, and the courses of instruction of different kinds. Our long vacation, which so many times has been depreciated in its value, is of great value in that it enables natural science people to go into some original research and investigation, without which, on the part of the teachers, I believe that natural science is not so good as many toher kinds of teaching; a natural science teacher who does not work originally at something or other is a less valuable teacher than a person similarly devoid of original research in other branches.

3242. Do you not think that a professor ought to be relieved of the drudgery of actual personal teaching; should he not leave that to be done by a demonstrator under his orders?—I think that it should be so; but that tells in two ways. If a professor is wholly relieved from it he ought then to put out a number of lectures which would bear printing immediately, and which should be worthy of the University as a seat of science, and not merely a centre for education. Then the number of lectures of that kind which a person could put out would be limited in number and would be addressed but to a limited circle, whilst standing in the place of the good influence which personal intercourse gives life to.

3242a. Do not you think that the best method of teaching is that the professor should give all the more general and broader views relating to his subject, and should endeavour to mass his subject in such a way as to take the attention of the students, and that

he should leave the indoctrinating of the students in the details in the hands of subordinates acting upon his general plan?—My views as to the way in which the professor should address himself to his duties on the one side to learning and on the other to teaching, and as to the character of his lectures are more or less implied in what I said with reference to the necessity of having demonstrators, in the proportion of one to 16 students, as one of the means for the reconciliation of the rival interests of teaching and of research that I would adopt. I am not at all in favour of the professor's being entirely silent, either as regards his class in the way of lecturing, or as regards the public in the way of research.

3243. Supposing a professor gave a moderate number of lectures, do you think that that would really interfere with his researches; would it not rather be a good thing for him to have to look over the whole subject once a year?—My answer to that certainly would be in the affirmative; but I should be sorry to pledge myself to saying that you should in all cases demand of all persons who are to occupy the professorial chair the delivery of a certain number of lectures, for I believe that money could not be put out to much better purpose than that of securing an eminent man on the spot. I believe that securing an eminent man to reside in a seat of learning is sometimes a most important thing to be compassed, even though such a person should not deliver many *vivâ voce* harangues.

3244. But, looking upon Oxford as a place of general education, surely it is of profound importance that the professor, who has or ought to have a grasp of the whole subject, should be able to put it forward in his lectures in such a way as to make it accessible to persons who are there only for general culture, and however eminent a man may hold the position of professor, if he is not able to do that is he not really sacrificing very much the interests of science as a part of general culture?—I am afraid that I hold views which may be considered a little pedantic upon that matter. I believe that a person to get real good from *coup d'œil* views of the entire field of science must have tilled some one small plot of ground in that vast landscape for himself. I do not think that very much good is done by those kind of lectures which profess to put persons *au courant* on a level with what scientific people are doing when they themselves are persons of merely literary culture.

3245. But the suggestion to which my question tended was the doing both. I entirely agree with you as to the impossibility of teaching science by talk, but surely it is possible to do both; that is to say, that the professor should give his general views upon the whole subject, and that the students should be disciplined in actual practical work, as far as is good for them, as a supplement to that; and in that case it does not appear to me that the giving a moderate amount of lectures is really any hardship or impediment to the professors?—We are all kept right, I apprehend, by the operation of two motive powers—private conscience and public opinion; and in appointing a person whom you wish to do right you should take all means to keep those two agencies, or at least, the one which you can control playing upon him. I think that a professor should, like other men, be submitted, if possible, to the agency of healthy public opinion, and although you cannot control the individual mind, you can command the help of public opinion to some extent by making him publish something. Some of the old University statutes did aim at that object by saying that such and such persons should print something, and although I do not think that our ancestors were always wiser than we are in legislation, yet still every now and then they may have been right; and in making a person print something, and publish it, you make him submit himself to public opinion, and that is what you want to do.

3246. Supposing that you were inclined, we will say, to make special researches upon the sponges,



very elaborate and far in advance of what anybody else would be able to produce, do you think that by making and publishing those investigations, however great distinction you might obtain by such a work, you would be doing the same service to science as part of the culture of the University, as if you gave a series of perfectly sound and profound, but at the same time clear lectures upon the principles of biology to persons passing through the University?—If you will be so good as to look at my second head, under viii. A. 2, you will perceive that I have anticipated that question a little. I there speak of the advisability of creating chairs for men as a principle to be acted upon as well as, if not as often as, that of educating men into fitness for filling chairs. I think, that money might very well be bestowed in rewarding men for proficiency in some special line. Some men can speak in print who cannot speak in a lecture-room.

3247. But might not that be done in some much better way than at the expense of the professoriat, that is to say, might not the fellowship fund be applied to that purpose very advantageously?—I should be quite ready to adopt that. If a college wished to do something for science at any one time, it might perhaps put its money to no better end than that of rewarding, when well advised, some person who had attained to a great eminence in some special line of activity, possibly one as unremunerative ordinarily as the one you have mentioned.

3248. (Chairman.) Now will you give us your opinions as to the best means of choosing teachers and professors?—I think the plan which I should adopt would be a little different from what most persons have put forward, though I believe that Mr. Vaughan did urge it before the first University Commission. It would be that the professors should not all of them be appointed by the same board. I think that by creating a spirit of emulation between the different boards you would be likely to pique each board into electing the best men, regardless of all consequences. But the scientific board that I should be glad to see would be some such board as this: a board of not more than five, so that the responsibility is not divided. Then, although I do not wish to see any interest, whether scientific or other, unfairly protected and predominant, I nevertheless think that, perhaps, under the circumstances, it might be better to have three out of five scientific men, and those three out of five scientific men might perhaps be divided between some of the professors *in pari materie* on the spot; and then I would suggest the President of the Royal Society, or the President of the Chemical Society, or both, and, in some special cases, the President of the Astronomical Society, to make up the other two; then I would suggest that some person to represent the source whence the money came for the endowment of the professorship should make the fourth; and some entirely extrinsic interest, say such a person as the Minister of Education, if there be one appointed, should be the fifth. That, I think, would be a typical board, and a very good board; a board consisting of five, three scientific persons chosen in that way, say, one scientific man for Oxford, or the President of the Royal Society, or say the President of the College of Physicians, or of the College of Surgeons, or of the Astronomical Society, or any one of those persons, as the case might be. I would not set the President of the College of Surgeons to act upon the board for electing professors of astronomy, nor the President of the Astronomical Society upon the board for electing professors of surgery; but I would take persons who, by virtue of their position as prominent officials, are, firstly, amenable to public opinion, secondly, interested in, thirdly, accustomed to act together in promoting the welfare of the science concerned. The other two electors to be chosen on the other two grounds specified.

3249. Do I understand you that all professors are appointed by the same board at Oxford?—No, not now. We have a great number of boards: there are some boards whose decisions I should be sorry to

question; whereas some others are by no means equally good. There are two other ways of appointing professors which I think deserve consideration: one is the appointment by the Crown, and I think there is much to be said for the Crown appointing some professors; and there is another way still which I think would make up the sum total of the means for appointing professors, and that would be this, the resident educational body, which should be the congregation of the University, which the congregation of the University is not at present, for the congregation is made up of all the masters of art resident and not those masters of arts who are engaged in education. Supposing there were three professors in each single subject, I should be glad to see that one should be appointed by the Crown, that one should be appointed by the mixed scientific board which I have spoken of, and that the third should be appointed by the resident masters of arts engaged in education. I think you would then have three sets of professors, and each electoral board would be acted upon by a sort of wholesome jealousy of the other in appointing its own professor.

3250. What guarantees could in your opinion be taken for the activity and efficiency of the professors?—I am sorry to say that I have no guarantees, as far as my experience of appointments goes, beyond those which the study of human nature furnish. I think if you take means for subjecting a person to as much public opinion as can be brought to bear upon him that really is the only guarantee that legislation does secure. I do not think that any amount of formal enactments will make a man correct either in his duties or his pursuits, or anything else; it is only the existence of public opinion and his own notions of duty that you can rely upon. The German example in that matter I think is very instructive. I believe that there is no very lengthy programme of duties laid down for the professors in the German universities. There, an institution which goes by the short name of "Ruf" exists. A professor is called to take a chair, and the amount of public opinion, and the enlightenment of the people, at all events, in many parts of Germany, which enlightenment comes to bear upon him, throws a light upon all he does, subjecting him to the full blaze of public opinion, keeping him up to his duty. I do not think that if you have any number of formal enactments, or lay down any amount of programme of duties for a man, if he does not wish to do them he will do them. I think it very inexpedient to lay down rules which you know may be neglected. The thing is to get as much public opinion as you can. If you can by any means get a person to subject himself to public opinion it is far superior to formal enactments or programmes, or schedules of duties.

3251. Do you think that anything in the shape of retiring allowances to professors advanced in years is desirable?—I have not considered that subject.

3252. What is your opinion as to the relation which ought to exist between professors *in pari materie*?—I think that if one professor is independent of another, the other should be independent of him too; that they should be allowed to settle, as sensible men would settle, what parts they will take in this *pari materie*, so as to avoid any waste of force in a small town such as a University town, like Oxford is.

3253. Does that question arise at present at Oxford?—I should be glad to see another professor co-ordinate with me, taking one or other of the two lines which I am expected now to labour in. There are two professors of modern history, two of modern philosophy, and several in theology; and I have never heard that they do not agree to take different lines of subjects, and so on.

3254. Do you think that the number of students might be increased by the removal of certain artificial restrictions?—Yes, I think that there are certain artificial restrictions which should be removed; and speaking from my experience, looking to the facts as they fall under my own observation, I attach considerable importance to the removal of them. Those

G. Rolleston,  
Esq., M.D.,  
F.R.S.

15 July 1870.



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15 July 1870.

artificial restrictions are these: that a man has to pass two examinations, his responsions, or "little go," and his moderations at certain fixed times. At Oxford we have combined or, rather, confused regulations as to residence with regulations as to examinations. A man is not allowed to pass or attempt to pass certain examinations *en route* to the B.A. degree till after a certain term or terms. I think if a man has his knowledge producible, it does not concern the examining board much for how long a time he has been employed in possessing himself of that knowledge, and, considering that the amount of literary culture that is testified to by the moderation examination is really very small, I would allow men who could pass it to pass it whenever they were able to pass it; by that means many men would get rid of their literary examinations altogether, in very much less time than by the end of their first year, and the very fact of a man's working amongst other young men with the object of passing an examination sooner than others would be a very wholesome spectacle, for he would *ex hypothesi* be working harder than other men. It is examples of that kind that we want, and very much want, at present in Oxford. By that means a man would be able to come sooner to natural science, and he would have been dignified and cultured by working for a desirable object at some slight pressure for some time previously. Then at the other end of a man's curriculum artificial restrictions of a closely similar kind exist. If a man does not present himself for examination in 18 terms he does not get any honours at all. I would allow a man who had got honours in any one subject whatever, after that to be free to go on working for honours without any restriction whatever, trusting to the limits of the parents' powers of sustaining sons at the University; and, on the other hand, to the bribes that the outside world, with its careers, offers to persons, for preventing men from exceeding reasonable limits in their residence at the universities. There are, of course, advantages and disadvantages in this as in most other plans, but I think a student who comes up to the University at 18, and has got honours, is quite old enough to be introduced to the business of choosing for himself. In such a case as this he would say: Is it worth my while to stay and get more honours at the University, or had I better have done with it altogether, and go out into the world at large? And I think that a student at the age at which we have students now is quite old enough to settle such questions as that for himself. I have a remark here which I should wish to make, and which is just this, that by the adoption of the plan of affiliation of colleges in other towns our numbers would be increased considerably. I would say that you will find this plan of affiliation given in the appendix to the blue book on Mr. Ewart's Bill for doing away with the necessity of residence in colleges. A report is there given by a sub-committee, of which I was a member, and of which Mr. Goldwin Smith was the president, in which the plan of affiliation is expounded at length. All that I could say about that will be found in the appendix to the report on Mr. Ewart's Bill for allowing persons to be members of the University without being members of colleges. The main points of the scheme are these: that the students should have two years of education in whatever affiliated institution they might choose, living either under their parents' roof or elsewhere; that this third year should be spent somewhere in Oxford, thirdly, that the University was to have a share in the governing body of those institutions, which had charge of the education of those persons during the two years not spent in Oxford. (See "Special Report," Oxford and Cambridge Universities Education Bill, 1867, p. 292.)

3255. What are your views as to the relations that the natural science teaching of Oxford should hold to the needs of the country?—I think it is of great importance that we should confer degrees for natural science as a sort of stamp to be put upon a man—as a

sort of trade mark of the real value that he is to the country, and I think it is the duty of the University to afford opportunities to persons who have special calls to improve those special calls, and give *la carrière ouverte aux talents*, as the first Napoleon used to say; because, in the absence of such opportunities, a considerable part of the national capital which lies in the special abilities of particular persons may be lost permanently.

3256. Would you have degrees in science?—No, I think not; but I think at present we are very liberal in that way. We set a person free after a certain amount of examination, and give him the same B.A. degree which we give to persons who go out in the older curriculum. I do not think that giving degrees in science and calling a person B.Sc. is at all giving him a better thing than giving him a B.A. degree. By calling a person B.A. I think it is understood that he has had a certain amount of general culture; but bifurcation I do think is inexpedient here. I would call them all B.A.'s, but it is not a matter that I feel very strongly upon.

3257. (Dr. Sharpey.) Do any of the pupils become teachers?—Yes, a considerable number do.

3258. In considerable schools?—Yes, a considerable proportion in schools of that character. For example: of the first class men in the natural science class list of last October term, who were 10 in number, I know that nearly every one has either found a place in some one of the great schools—Clifton is one school, for example—or got some educational employment; they all get well placed in that way now.

3259. And they teach natural science?—Yes.

3260. Do any of the pupils engage in original inquiry?—Yes, some of my pupils have written and are writing papers from time to time. Dr. Church, for example, and Mr. Galton, and others mentioned above.

3261. Do you think that the practical school of physiology might be advantageously used for a place for original research?—I think so. I do not think that physiology, if you contrast it with anatomy, is so good a subject for a gymnastic of the mind; it requires the application of physics and chemistry in such combined and complex methods that really one cannot expect it from young men, but I think it is of great consequence that there should be professorships of biology multiplied.

3262. And that you think might be done in colleges by conferring fellowships upon men who have distinguished themselves in particular branches, and who might be required to devote a part of their time to lecturing?—I think for such a large subject as physiology I should like to see the professor of physiology definitely a university professor, and co-ordinate with myself; but for the *professores extraordinarii* I would look to the colleges; but in dealing with a large matter like the professorship of physiology I would put it in relation to the University directly. *Professores extraordinarii* I would not consider as permanent appointments, so that when a *professor extraordinarius* died he was not necessarily succeeded, but for the other professor of physiology, I should always have a succession.

3263. Have you considered in what way the public money might be applied advantageously for furthering original research in science generally, or in your own science in particular?—I have not any views upon the subject sufficiently matured at present to be put before the Commission.

3264. With reference to the body who should appoint the professor you spoke of five persons, some of whom of course should be conversant with the subject of the professorship; would you prescribe any line of proceeding to them, for example, such as referring all applications of candidates, with evidence of their fitness, to a committee of persons selected for the occasion, who should report to the elective body?—I think they should be a committee themselves able to do it.

3265. Then it would appear that in the case of professorships of science, the opinion of the men of



science in a mixed committee would guide the others entirely, or in a great measure?—Yes, I think so.

3266. Are you aware of the arrangements in some institutions, by which the governing body submits all applications and evidence of qualification of candidates to the professors or others, who then report to the governing body upon the comparative fitness of the different candidates, not simply recommending one individual candidate, but comparing the qualifications of all, and endeavouring to assign the proper value to each; do you think that that is a good system?—I always think that in matters of this kind you must have the responsibility undivided, and if I had three scientific men, by there being only three I should feel that each of them had the responsibility, and was obliged to take all the best means for obtaining infor-

mation; but by having intermediate committees the sense of responsibility is deadened I think.

3267. The arrangement I referred to is a mode of obtaining information, is it not, and coming to a judgment upon the report of the intermediate committee?—If for each professorship there were a board selected that had a special interest in it, I think they should be persons who *ex hypothesi* were thoroughly *au courant* with literature, and a knowledge of the subject that they had to deal with, so that they should not be enabled to shelter themselves behind the verdict of any other body, but stand entirely by themselves. I feel strongly upon that point, that the persons ought to be experts themselves, and ought not to be able to throw the blame of a bad election upon any other shoulders.

The witness withdrew.

Adjourned to Thursday next, at 11 o'clock.

No. 6, Old Palace Yard, Westminster, Thursday, 21st July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

The Rev. BARTHOLOMEW PRICE, M.A., F.R.S., examined.

3268. (*Chairman.*) I believe you are Sedleian Professor of Natural Philosophy, a member of the Hebdomadal Council, and Curator of the University Chest at Oxford?—Yes.

3269. Can you state to the Commission generally the character of the scientific instruction now given at Oxford?—I would, if you would allow me, rather speak as to what the University can, and in my opinion ought to give; and that is a general and purely scientific instruction, as distinguished from professional or technical instruction.

3270. Do you think the instruction now given at Oxford is all that is desirable?—No, I do not.

3271. Will you point out to us now what you think is desirable?—The education there has mainly been in classics and mathematics—chiefly in the classics, and to a small extent in mathematics; and I think it is desirable that a general and purely scientific education should be added; not to the exclusion or the superseding of either the one or the other of these, but in addition to them.

3272. What are the branches of scientific instruction which you think ought to be embraced in the Oxford curriculum?—The three general branches which we have now; for these include everything that can be or ought to be taught there; viz., physics, chemistry, and biology: physics, including mechanics, light, heat, sound, electricity, and magnetism; chemistry, as well organic as inorganic; and general biology as distinguished from professional biology.

3273. What is your opinion as to the question of mathematics being indispensable or otherwise?—It appears to me that for a general education in those particular branches, a competent knowledge of mathematics should be required in all cases. I think it most important that a student in those departments should have that familiarity with *quantity* and *form* which can only be acquired by a competent study of mathematics. The knowledge which I consider to be requisite need not be very great, but in all cases should include geometry, algebra, and elementary trigonometry; algebra, perhaps, rather further than is now given in the ordinary text books; for the laws of variation, and of combination, being those which are especially illustrated in chemistry, should be familiar to the mind of every student of natural science.

3274. How far do you think literary training absolutely necessary?—I think it is very undesirable to teach a scientific course exclusively unless care is taken that there is a sufficient foundation of literary acquirement, because an education in the former branch without the latter would be very imperfect. Deficiency of literary accomplishments is frequently noticeable in natural science students. In papers written by natural science students that come under my observation, I frequently see very great and flagrant defects in the power of expression, and in literary ability generally. It does not appear to me to be any want of power, but a defect in instruction. Moreover, I should be very sorry to see the study of all the ancient languages given up by students in natural science. I am quite prepared to surrender Greek, but I should wish to retain Latin; and in place of Greek to substitute the English language.

3275. Do you think that a sufficient literary training should be obtained by students previous to coming up to the University?—I think there should be, and I do not doubt that there would be by boys educated in the best schools. The University, however, should, I think, protect itself by an examination-test whether there is sufficient literary acquirement or not; but I would not be misunderstood as to a matriculation examination, because opinions are divided upon that point, and I cannot say that my opinion upon it is so clear that I can speak very positively.

3276. Do you think that there should be a matriculation examination at all?—I am not clear upon that, and I will give you the reason why. Many of our young men come up, who, previous to matriculation, have had no opportunities of getting good instruction, and I should be sorry to deprive them in the early part of their career of the opportunity of obtaining that instruction which they can get in Oxford and, perhaps, cannot get elsewhere; and therefore my opinion inclines towards an examination at an early period in their course as preferable to a matriculation examination.

3277. With regard to those who have passed such an examination as you desire at the end of the first year, would you then set them free from any further literary pursuits?—I should do so.

3278. You mean those who were desirous to engage in scientific study?—Yes; and I would extend it to

G. Rolleston,  
Esq., M.D.,  
F.R.S.

15 July 1870.

Rev. B. Price,  
M.A., F.R.S.

21 July 1870.



Rev. B. Price,  
M.A., F.R.S.

21 July 1870.

those who are desirous to take the line of law, or divinity, or any other faculty; and that is the general principle which my opinion leads to, which is, that there should be a literary education in the earlier part of a student's course; and he should be allowed subsequently to go on in whatever line his profession or his natural taste leads him to take.

3279. Oxford has now, I believe, provided considerable appliances for scientific instruction?—Yes.

3280. Will you be so good as to give us all the information in your power with respect to those appliances for scientific instruction?—We have, in the first place, a museum, lately erected, which is entirely devoted to the various purposes of teaching natural science. The total cost of it up to the present time, including purchase of land, building, architect's commission, fittings, and some apparatus, but not the whole of the apparatus, is not less than 85,000*l.*, beginning from the year 1856, and coming down to the end of the year 1867; and down to the present time it has been nearly 100,000*l.*, as near as I can estimate; it may be 5,000*l.* short or 5,000*l.* in excess of that. That sum of money has been wholly defrayed out of the corporate funds of the University, by the votes of Convocation.

3281. (*Mr. Samuelson.*) I believe that that sum is exclusive of the apparatus which was in existence before, and which was transferred?—Yes, exclusive of that.

3282. Can you give the present value of that?—No, I cannot; Dr. Acland or Dr. Rolleston would be able to speak of the physiological collection which has been lent by the authorities of Christ Church, and Professor Phillips can speak of the value of the geological collection. That sum is also exclusive of the cost of the new Hyde institution, which is a physical laboratory; the University, however, has made a grant of 1,000*l.* for the apparatus of this institution.

3283. (*Chairman.*) Can you tell us what is the actual cost of maintaining the museum?—The annual cost of maintaining the museum at the present time is 2,451*l.*: viz., for general purposes, 995*l.*; chemistry department, 626*l.*; physiological department, 90*l.*; physical department, 655*l.*; zoology, 85*l.* The library and its officers are maintained by the Radcliffe trustees, and the cost of the library is not within our cognizance. Of the sum which I have mentioned the University contributes out of its corporate funds 2,075*l.*, and certain trusts contribute 376*l.* Going into further detail, the University contributes for the museum for general purposes 645*l.*; maintaining collections, 250*l.*; repairs, 100*l.* To the chemistry department the University gives 500*l.*, and Dean Aldrich's fund contributes 126*l.* In the physical department the University contributes 565*l.*, and a fund left by Lord Leigh, for buying apparatus, yields about 90*l.* a year. In zoology the University contributes 15*l.* for a servant, and the Hope fund gives 70*l.* I think you will find that these will amount to 2,451*l.*, of which the University gives 2,075*l.*, and the trust funds 376*l.* This includes apparatus, attendants, assistants, and demonstrators, but is exclusive of the payments made to the professors. The payments made to the professors attached to the museum amount to 4,350*l.*; namely, the professors of astronomy, geometry, natural philosophy, geology, mineralogy, zoology, chemistry, physiology, experimental philosophy, and the keeper of the museum, of which amount the University contributes 980*l.*; the colleges contribute out of their funds 2,170*l.*, and trust funds give 1,200*l.* The Savilian endowment of the professors of geometry and astronomy is about 300*l.* a year to each, and New College at present contributes 150*l.* to each, and in five years hence the contribution to each from New College will be 300*l.* a year; the present professor of geometry is also a Fellow of Balliol College. The Sedleian professor of natural philosophy receives 200*l.* a year from the Sedleian endowment, 100*l.* a year from the general fund of the University, and 270*l.* a year from Queen's College. The contribution from Queen's College is by ordinance attached to the professorship. He is also a Fellow of Pembroke College. The professor of geology receives 400*l.* a year from the general fund of the University,

and the present professor is also the Keeper of the museum. The professor of mineralogy receives 100*l.* a year from the general fund of the University, the general endowment being 300*l.* on fulfilment of certain conditions, which the present professor does not fulfil. The professor of zoology has 400*l.* a year from the Hope fund. The professor of chemistry receives 600*l.* a year from Magdalen College. The professor of physiology receives 800*l.* from Merton College. The professor of experimental philosophy receives from the University 300*l.* a year, and from Wadham College 200*l.*; Wadham College having elected to pay 200*l.* a year instead of giving a fellowship. The present professor is also a Fellow of Merton College. The keeper of the museum has 80*l.* a year, and a residence. It was proposed to give him 200*l.* a year, and the house is reckoned at 120*l.* a year. If the Commission wish I will hand in the following tables, which exhibit summarily the substance of the preceding evidence.

MUSEUM GENERAL FUND.				
	£	s.	d.	£ s. d.
University: for general purposes	645	0	0	
maintaining collections	250	0	0	
				895 0 0
repairs, insurance, &c.				
(say)	-	-	-	100 0 0
Chemistry Department (University)	500	0	0	
Aldrichian Fund	126	0	0	
				626 0 0
Physiological Department:				
Aldrich and Tomlins' estates	-	-	-	90 0 0
Experimental Philosophy Department:				
University	565	0	0	
Lord Leigh's Fund	90	0	0	
				655 0 0
Zoology:				
University	15	0	0	
Hope Fund	70	0	0	
				85 0 0
				£2,451 0 0
The Library is maintained by the Radcliffe trustees—				
Thus the University contributes	2,075	0	0	
Trusts, &c.	376	0	0	
				2,451 0 0

PAYMENTS TO PROFESSORS ATTACHED TO THE MUSEUM.				
	£	s.	d.	£ s. d.
Astronomy: Savilian endowment	300			
New College	150			
				450 0 0
Geometry: Savilian endowment	300			
New College	150			
				450 0 0
Natural Philosophy: Sedleian endowment	200			
General Fund of University	100			
Queen's College	270			
				570 0 0
Geology: General Fund of the University	400	0	0	
Mineralogy (General Fund of University)	100	0	0	
Zoology (Hope Fund)	400	0	0	
Chemistry (Magdalen College)	600	0	0	
Physiology (Merton College)	800	0	0	
Experimental Physiology: University	300			
Wadham College	200			
				500 0 0
The keeper of the Museum (University)	80	0	0	
				£4,350 0 0
Which total is made up of—				
University Fund	980	0	0	
College	2,170	0	0	
Trusts' Fund	1,200	0	0	
				4,350 0 0
Thus the total annual payment to the museum and its professors out of the General Fund of the University is—				
Museum	2,075	0	0	
Professors	980	0	0	
				£3,055 0 0

This statement is also exclusive of the medical department and its professor, the emoluments of the latter arising from special trust funds, and not charged on the general account of the University.

3284. (*Mr. Samuelson.*) Is the Radcliffe library essential to the objects of the museum, or is it an accidental combination?—A scientific library, in my opinion, is necessary; and if the Radcliffe trustees withdrew their collection of books, which it is competent for them to do, we should be obliged, I think,



to procure books from some other sources for the use of the students, and for the use of the professors. I may mention that the Bodleian library contains a very large number of scientific books and serials, and is continually making additions; and that it now lends a considerable number of books to the museum.

3285. A scientific library being essential, and the Radcliffe library supplying that want, can you form any approximate estimate of the cost of the maintenance of the library?—That does not come within my province.

3286. Can it be procured?—Dr. Acland can probably give you that, as he is the librarian.

3287. (Chairman.) Do you happen to know whether there is a fixed sum annually allowed for the maintenance of the library, or for making additions to it?—I cannot give any information. The management of the library does not come within the province of the University; it is an institution managed entirely by the Radcliffe trustees.

3288. (Mr. Samuelson.) What do you think would be the extra expense of maintaining a scientific library, assuming that you had not access to the Radcliffe library?—I cannot say. Our Bodleian contains a very large collection of books; and these probably might be available for the use of the museum.

3289. Are there any other sums which could be fairly charged to scientific instruction and the promotion of science in the University of Oxford in addition to those which you have named?—Yes, there is Dr. Lee's fund at Christ Church, which is, I believe, partly applied to scientific purposes; but it is under the management of Christ Church, and I know nothing about the details of it.

An ESTIMATE of the present yearly INCOME and EXPENDITURE of the University, put forth by the Curators of the Chest, in order to furnish better and more exact information than an Account of the Receipts and Payments of any particular year can give.

INCOME.								
			£	s.	d.	£	s.	d.
Rents	-	-	-	-	-	8,429	0	0
Benefactions	-	-	-	-	-	323	0	0
Dividends on stocks	-	-	-	-	-	2,136	0	0
Dues and Fees, as received for 1868-9 :								
Dues	-	-	-	5,994	0	0		
Matriculation fees	-	-	-	1,638	0	0		
Degree fees	-	-	-	6,278	0	0		
Examination fees	-	-	-	2,507	0	0		
Fees and dues from unattached students	-	-	-	178	0	0		
						<hr/>	16,595	0 0
The market	-	-	-	-	-	400	0	0
Fines	-	-	-	-	-	300	0	0
Wine licenses	-	-	-	-	-	200	0	0

£28,383 0 0

3290. (Chairman.) Can you give the Commission any information as to the sources from whence the University income is derived?—The present income of the University, as it can be best estimated, is, 28,383*l.* a year. I take this sum from a printed paper, which, with your Grace's permission, I will hand in to the Commission. Rents in gross are 8,429*l.*, benefactions 323*l.*, dividends on stocks 2,136*l.*, dues and fees, that is, the University taxation on the members, 16,595*l.*; various other sums, consisting of profits from the market, certain proctors' fines, and wine licences, amounting to 900*l.*

3291. What are we to understand by benefactions?—They are small benefactions made to the University for general purposes at various times. Some are Crown benefactions, given by Henry the Eighth, George the First, and George the Third; and there is a small sum of 140*l.* which comes out of the Treasury, I think; and part of a benefaction of 200*l.* a year given by Lord Crewe Bishop of Durham; and also a small part of a gift of Sir Henry Savile, are applicable to the general purposes of the University. This does not include any income derived from the press; the press is a large commercial establishment, and must be treated as such; so that we cannot estimate or count upon any *certain* income derivable from it. The sum transferred from the press last year was about 1,300*l.*

3292. That does not appear in the account of the income of the University?—The estimate which I now hand in does not include any moneys derived from the press. (*The following estimate was delivered in*):—

EXPENDITURE.						
	£	s.	d.	£	s.	d.
Stipend of officers	-	-	-	3,824	0	0
Do. examiners	-	-	-	2,382	0	0
Do. professors	-	-	-	4,626	0	0
Fees for presentation to degrees	-	-	-	100	0	0
On account of benefactions	-	-	-	313	0	0
Institutions :						
St. Mary's Church	-	180	0	0		
Preachers	-	320	0	0		
				500	0	0
Bodleian Library and Camera	-	-	-	3,615	0	0
Ashmolean Museum	-	-	-	130	0	0
Botanic Garden	-	-	-	242	0	0
University Museum:						
For general purposes	-	645	0	0		
For maintaining collections	-	250	0	0		
				895	0	0
Department of Chemistry	-	-	-	500	0	0
Do. Experimental Philosophy	-	-	-	160	0	0
Do. Zoology	-	-	-	15	0	0
The Park	-	250	0	0		
Public walks	-	150	0	0		
				400	0	0
Delegacy of lodging-houses	-	-	-	300	0	0
Do. unattached students	-	-	-	340	0	0
Police:—University police	-	900	0	0		
Joint police	-	1,200	0	0		
				2,100	0	0
Repairs and maintenance of public buildings	-	-	-	500	0	0
Quit rents, rates, and taxes	-	-	-	300	0	0
Expenses on Estates :						
Ten per cent. rents	-	850	0	0		
Extra for sea-wall and ferry at Elmley	-	150	0	0		
				1,000	0	0
Augmentation of vicarial stipends	-	-	-	225	0	0
Pensions and annuities	-	-	-	1,605	0	0
Printing	-	-	-	600	0	0
Expenses at the schools and the Clarendon building	-	-	-	300	0	0
Legal expenses, prosecutions, maintenance of prisoners	-	-	-	500	0	0
				26,472	0	0
Total of ordinary expenditure	-	-	-	26,472	0	0
Extraordinary grants by Convocation	-	-	-	1,911	0	0
				28,383	0	0
Balance in favour of the University	-	-	-	1,911	0	0
				28,383	0	0



Rev. B. Price,  
M.A., F.R.S.

21 July 1870.

3293. As a general rule, has it or not been usual to invest the income derived from the Clarendon press? —There have been such heavy charges upon the University fund in building the museum, and other charges of the same kind, that the money paid over by the Clarendon press has been disbursed for the purposes of the University without being first invested. The terms of the statute order it to be invested; but if it had been invested, it must immediately have been sold out again to pay the current demand, so that the managers of the fund thought that it was unnecessary to pay commission for both those processes.

3294. Then it has been applied rather in buildings than in meeting the annual expenditure of the University?—Not wholly in building, though probably chiefly so.

3295. I see that amongst the heads of income are included dividends on stocks; have those stocks in any cases been purchased with money derived from the Clarendon press?—I cannot say exactly the source from which they come, but I have no doubt that they have partly been purchased with moneys paid over from the Press. You will observe that the chief source of income is the taxation. There are dues of 1*l.* a year payable by every member; and those dues amounted to 5,994*l.*; members also are allowed to compound, and there is a composition fund of between 13,000*l.* and 14,000*l.*, being money paid by the members of the University for the composition of their dues, and which is invested by order of statute in Government securities. Matriculation fees amount to 1,638*l.* Every member that matriculates pays 2*l.* 10*s.*, except noblemen, who pay more; I do not remember exactly their fee; a bible clerk pays less, 10*s.* 6*d.* I think. The degree fees are 6,278*l.*, the examination fees 2,507*l.*, and the fees and dues from unattached students 178*l.*; these last are students who are not members of colleges or halls; this is a source of income only arising within the last two years.

3296. (*Mr. Samuelson.*) How much per head is that for unattached students?—That amount includes more than a year; the matriculation fee is 5*l.*, but these students have certain fees to pay to their tutors, and the residue is the balance of the fee. Moreover I should observe that the preceding is the corporate income; it does not include any of the trust funds, and there is a large amount of such funds, but I cannot tell the amount.

3297. Is the University the trustee?—The University is in many cases the trustee, and in other cases it is the acting body; the actual trustees give a power of attorney to the University to receive the dividends.

3298. (*Chairman.*) Do you think it would be possible to increase the University income so far as it is derived from dues and fees?—I doubt it, and for this reason: with regard to members of Convocation many complain now of the dues being large, and I think if they were increased, many would withdraw their names, and the result would be a loss. With regard to undergraduates we might increase their fees in the earlier part of their career, but there would be an unwillingness to lay further taxes upon them.

3299. Are the present school dues and fees much the same as they have been for some years?—Yes, generally.

3300. The demands upon the ordinary income approach very nearly to the amount that is disposable?—Yes, the ordinary corporate income of the University is only about 3,000*l.* in excess of the ordinary expenditure; then putting 1,000*l.* for extraordinary grants, there is left a margin of say 2,000*l.*, and the University expenditure increases year by year.

3301. (*Dr. Miller.*) What proportion of the funds is expended in scientific education, and what in general purposes?—The University contributes towards the maintenance of the museum 2,075*l.*, and in contributions to the scientific professors' incomes 980*l.*, making a total of 3,055*l.*

3302. That is about one tenth of the whole, is it not?—Yes. The Bodleian Library also, which is a scientific library as well as a literary one, costs the University 3,615*l.* a year.

3303. Is that one of the privileged libraries?—Yes. But besides the privilege, a very large sum is expended in the purchase of books; this sum also is not one half of the expense of the library.

3304. (*Chairman.*) Can you see any difficulty in providing funds for the apparatus, and for the maintenance of the apparatus, required for scientific instruction?—If more is required it must come from some other fund than the general fund of the University.

3305. Do you anticipate that more will be required?—Yes.

3306. Have you thought of the means which should be resorted to to obtain those funds?—I know of no other source than fees to be paid by the students who attend the lectures, or contributions from the college funds.

3307. Do you think that the colleges would agree to tax themselves voluntarily?—I cannot say; but it may be that it is not competent to them to do so; perhaps it can be done only by parliamentary interposition.

3308. Do you think that the colleges would be disposed to make a voluntary application to Parliament for power to apply their funds in this direction?—I cannot say.

3309. Is the income derived from college endowments generally increasing?—Yes, I think so; but I do not know what is, or what has been the amount of the college endowments; it is variously estimated from 150,000*l.* a year to as much as 300,000*l.* a year.

3310. Is it generally in land?—Yes.

3311. Then the increase is owing to the increase of rents?—Yes, and in a great measure to a very indirect cause; to the operation of the College Leasings Act, by which our corporations can grant leases for more than 40 years: and as a large quantity of land has become available for building purposes, a large income is derived from it.

3312. Do they succeed in getting lessees to take leases for 40 years?—Only to a very limited extent; but they have further powers. We were hindered by not being able to grant leases for more than 40 years; then the College Leasings Act passed, and we can now grant leases for longer terms, and they are taken at terms of 80, 90, and 99 years.

3313. Have any of the colleges any mineral property?—I do not know of any.

3314. Do you know the total amount of contributions made by the colleges at present for University purposes?—The colleges contribute 2,170*l.* towards the payment of scientific professors, and a large sum also towards professors in other departments: but I cannot tell the amount; it is very large. Thus Christ Church provides for five professors of divinity. Also, there are some college scholarships given for scientific purposes; the whole number of scholarships in the University is, I think, nearly 400; those are tenable upon the average about four years, and I take it that nearly 100 scholarships and exhibitions are given away every year; of these, I think, fewer than 10 are given for scientific attainments. Perhaps not more than five are given yearly; a few more are given for mathematics; there may perhaps be 15 or 20 annually given for mathematics; but the majority of them are given for classical attainments.

3315. Would it be correct to say that about four-fifths of the scholarships are given annually for classical attainments?—Approximately that would be correct, I think, as far as I can speak without having the actual figures before me.

3316. Is that about the proportion of the students in the different branches of learning?—I cannot answer that question. These 100 scholarships are upon the average worth 70*l.* a year, making 7,000*l.* a year, or about 28,000*l.* given annually in scholarships, and the scientific students get a very small part of it.

3317. Is there much competition for the physical science scholarships?—Not much, I believe.

3318. Do you think that the number would be increased if the scholarships were increased in number?—I have no doubt it would.

3319. (*Mr. Samuelson.*) Are the individual scho-



larships equal in amount to those given for classics?—The classical ones are in many cases more valuable than the mathematical or natural science scholarships; not in all cases, but in most cases.

3320. (*Chairman.*) I believe it is only comparatively recently that any scholarships have been given to natural science?—Yes, quite recently.

3321. Does that remark also apply to mathematics?—Scholarships were awarded for mathematics several years before they were given for attainments in natural science.

3322. (*Mr. Samuelson.*) Was the physical laboratory built out of some special fund?—Yes.

3323. What fund was that?—A fund created under Lord Hyde's will.

3324. By whom was the decision made with regard to what the application of that fund should be?—Convocation having declined to accept the riding school as proposed in Lord Hyde's will, the trustees determined on erecting physical laboratories.

3325. And the amount of 11,000*l.*, which you have mentioned previously as having been the cost of those laboratories, exhausted that fund?—Yes.

3326. Assuming that fund not to have existed, do you think that those laboratories would have been built by the University?—I cannot say.

3327. (*Chairman.*) Can you tell us the number of University professors at Oxford?—I cannot say off-hand.

3328. Can you tell us the number of physical science professors?—Ten, I think, including the professor of medicine.

3329. Do you think that additional professors in those departments are required?—I perceive the need of one more at least, and that is for applied mechanics and engineering.

3330. Are all the professorships endowed?—Yes; but with various incomes.

3331. Generally speaking, are they adequately endowed?—It is scarcely proper for me to answer that question; some certainly are not.

3332. Do they vary very much?—Very much. The endowments vary from 100*l.* a year to 800*l.*

3333. Does that include the incomes of fellowships attached to some of them?—Yes, but not the incomes of the fellowships which may be accidentally held in connexion with them.

3334. Do you think the largest amount a sufficient income?—No. When I say that 800*l.* is not sufficient, I mean if the professor's time is employed wholly in the work of the chair, so that he has no time for other remunerative occupation. Moreover, Oxford is in many respects an expensive place to live in; and if the professor has to provide a residence, it certainly is not enough.

3335. In your opinion it would be desirable that the incomes of all the scientific professors should be increased?—Yes; all the professors ought to have sufficient incomes.

3336. (*Dr. Miller.*) Is there any capitation fee allowed to the professors for pupils?—Small fees are allowed them.

3337. Do they not form any substantial addition to the income?—No. In the experimental departments they make, I believe, a very small addition. For each attendance on each course of lectures 1*l.* may be paid twice, but only twice. For experimental lectures a fee of 3*l.* is, I believe, paid each term.

3338. Does the professor bear the charges of this experimental course, or is that allowed by the University?—He partly bears it, and it is partly allowed. The sum of money allowed by the University is not adequate, and the professor makes up the deficiency.

3339. Are those experimental lectures, lectures or demonstrations?—Demonstrations.

3340. Does the pupil use the apparatus for the demonstration?—Yes.

3341. Does the pupil pay anything for the use of the apparatus or the materials?—I believe he pays for such materials as he breaks.

3342. (*Chairman.*) Do you think it undesirable

that the fee should be increased?—Yes, for two reasons: first, I think that the money can be found from other sources; and secondly, it would tend to discourage the study, unless similar fees are paid by students in all departments of academical instruction.

3343. How are the fees receivable by the professors, compared with the fees required for college tuition?—A student very generally, if not universally, has to pay 21*l.* a year for three years to his college for tuition fees; and in some cases the college out of this fund pays the laboratory fees, but in many cases it does not, and students often pay this tuition fee to the college when they never attend any lectures within the college. The college, however, finds them discipline and superintendence which may be of value.

3344. In any branches of science are there at present more than one professor?—No; and I think it is undesirable that there should be more than one; I should myself prefer to increase the number of demonstrators under the professor, and to keep one professor at the head of his department; you get concentration, better superintendence, and, as it appears to me, better arranged work.

3345. Have many of the professors demonstrators or assistants connected with their professorships?—Yes, in the case of the three greater departments; that is to say, in the three experimental departments; Professor Brodie, Dr. Rolleston, and Professor Clifton have each a demonstrator.

3346. Can you tell us how many students in your opinion a demonstrator is able to look after?—I would rather leave that question to be answered by those who are specially concerned in superintending demonstrations.

3347. Will you give us your opinion as to whether you think it desirable that provision should be made for the retirement of professors after a certain number of years' service?—I think there should be, and supposing the funds to be sufficient, and put under efficient superintendence, some means should be devised by which a professor should be enabled to retire after a service of a certain number of years. I think that is a most important matter.

3348. Must the fund required for that purpose be derived from University sources?—I would suggest that it is for the Commission to recommend the source from which it should come.

3349. Are you of opinion that all colleges ought to provide a fund for scholarships in physical science?—Yes, I think so.

3350. Have you at all formed in your own mind any idea as to how many you think it would be desirable should be provided by the colleges?—A certain proportion of all I think ought to be so provided.

3351. Do the colleges provide examination themselves for the physical science scholarships at present?—In some cases. But it is frequently done by their calling in the assistance of the professors, and this is very generally done in fellowship examinations. I have been employed in five or six examinations at various times.

3352. Some colleges themselves provide a certain amount of instruction in physical science, do they not?—Some do.

3353. And in those cases do the readers in physical science, or by whatever title they are named, conduct the examinations?—Yes, they do, but very frequently with assistance from the professors.

3354. Do you think, as a general rule, the examinations for those scholarships ought to be conducted by the professors?—Yes, I do, and in connexion with the central institution.

3355. Would you make the professors themselves examiners, or merely leave the appointment of the examiners with them?—I should make them or their assistants the examiners.

3356. And would you make the examination to be connected in any way with the museum?—Yes.

3357. What would be the advantages of such a course of proceeding?—To get a central institution

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21 July 1870.



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21 July 1870.

where you would have your teachers and your collections and your students; some students honoured by scholarships, and others studying with the object of obtaining these substantial prizes; this would act as a great encouragement to exertion on the part of all the students.

3358. What is your opinion as to the desirableness of granting degrees in physical science?—I think it is desirable that there should be a faculty of physical science, in the same way as in old days there were faculties of divinity, medicine, and law, of which merely the skeletons remain. Hereby we should get proficiency in a special subject represented by appropriate degrees.

3359. Would you distinguish degrees in physical science from degrees in arts?—Yes, I should make the faculty distinct; for I think it very desirable that students of physical science should enter upon the faculty at the beginning of their academical course. A degree in arts does not indicate any special attainment of its possessor. It has a conventional value, but I take it that that value depends more upon the fact of the possessor having been brought into connexion with an old institution like the University of Oxford is, than upon anything intrinsic which it has got itself. I think that a new degree, such as Master of Science, or Bachelor of Science, would very quickly, from its connexion with an old institution, obtain a value which is similar to that in which the degree of Master of Arts is now held. There is a feeling current in the University that there should be a faculty of law, and that students should start upon the faculty of law after their first literary examination, and similarly with the faculty of medicine.

3360. Is there not a faculty of law at present?—There is a faculty of law, but it is practically dead; nobody takes law degrees until he has gone through arts; there is scarcely a distinct law line.

3361. You would not think it desirable that a degree in arts should be indispensable for a degree in law, or a degree in science?—I think not.

3362. What would you confine a degree in arts to?—To non-professional men for the most part.

3363. Would this degree in physical science include examination in mathematics?—Yes; I think that mathematics should be an essential.

3364. Would you strike mathematics out of the arts examination?—No. I should wish to leave that course as free as I possibly could. I would not wish to exclude anything, but would try to include as much as I possibly could.

3365. Would you give the full rights of membership of Convocation only to those who had obtained degrees in science, or some of those degrees in the higher faculties?—The rights of Convocation are practically now limited to those who take degrees in arts. If a person does not take the master's degree in arts, but becomes a Bachelor of Law, or a Bachelor of Medicine, he is not a member of Convocation until he takes the higher degree. I should allow a person who has gone through any one of those faculties without previously going through arts to obtain the full rights of membership of Convocation.

3366. You mean that both Bachelors of Science or Bachelors of Law should be members of Convocation?—Yes.

3367. There is no examination at Oxford, is there, after the examination for a Bachelor of Arts?—There are examinations for Bachelor of Law, and also for the higher degrees in medicine.

3368. There is an examination for Bachelor of Law, but not after, I believe?—I think there is some exercise to be done afterwards. In medicine there is an examination for a Doctorship of Medicine as well as for a Bachelorship of Medicine.

3369. (*Dr. Sharpey.*) But not for a Master of Arts after a Bachelor of Arts?—No.

3370. (*Chairman.*) Still no one who does not become a Master of Arts becomes a member of Convocation?—If he take the highest degrees in medicine and

law, then he becomes so, but those higher degrees he cannot take without subscription to the 39 articles.

3371. (*Professor Stokes.*) Did I understand you to say that science was not on the same footing at Oxford as classics and mathematics?—Science is not valued there, so far as the substantial prizes go, as highly as classics and mathematics.

3372. But still the regulations of the University are such that it is free to grow to the same University estimation?—Quite so.

3373. But would you not consider the profession of engineering rather as belonging to technical education, which you do not consider as belonging to a university?—Of course it might be carried out to details of that kind which would be technical, but the general principles of engineering would not be so, as I take it. It is perhaps more a question of words than of anything else. You might perhaps call it applied mechanics. Take such a book as Professor Willis's; what I mean is that a student should read such a book as Professor Willis's, or some of Professor Rankine's, which are books upon engineering as I should call them; other persons might call them books upon applied mechanics; but what I think is, that the principles of mechanics both in the applications to engineering and to ordinary mechanics should be studied in the University. It would, however, be impossible to go into all the details of work, for these can only be done in large manufacturing shops. Just the same as in law, we cannot teach the work done in a barrister's chambers; but I believe we can teach the principles of jurisprudence, and the sound elements of legal education a great deal better than they can be taught in a barrister's chambers. So in medicine again, we cannot teach bedside practice, but we can teach the elements of physiology and anatomy; and chemistry and botany can be much better taught in Oxford than in hospitals. So I think the principles of engineering and applied mechanics may well be learned in Oxford, though for some of the details of machines, and so on, a student would have to go to the large industrial workshops.

3374. Have you not the means already of teaching applied mechanics?—Applied mechanics fall within the department of Professor Clifton, as it has been generally understood, but that department includes so many branches that there is not time for all, and the subject requires to be divided into two parts, viz:—1st, mechanics, &c; 2nd, heat, electricity, magnetism, light, and sound.

3375. You think that theoretical mechanics and mechanism ought to be taught together?—I think so. I do not mean theoretical mechanics to include mathematical mechanics involving high mathematics; that I should exclude.

3376. Is there provision for teaching that?—Yes, that comes within my department; but of course a question may fairly be raised, and fairly discussed, as to the most convenient divisions of the department.

3377. (*Dr. Miller.*) Is ignorance of the simple application of arithmetic to mechanics any bar to the ordinary course of instruction for the pass in Oxford?—No.

3378. So that a man may obtain a B.A. degree without actually knowing even the simplest principles of mechanics?—Yes.

3379. Do you consider that that is at present a desirable state of things?—Very undesirable indeed.

3380. Would it be easy to introduce such a modification into the examination for the degree?—Yes. The difficulty is that the instruction of the majority of the students is, for the most part, in the hands of teachers who are not acquainted with those things.

3381. With regard to the professorships, there are several professorships I think; for instance, the Waynflete professorships, in connexion with the University?—Yes.

3382. Are those University professorships?—Yes.

3383. What are the Waynflete endowments?—They are certain professorships established within Magdalen College, and paid out of the resources of that college, the lectures given by the holders of



which are free and open to the University. Professor Brodie holds one of them, and it is one of those which I class under the Museum professors. There are to be four of them; two are already founded; one of moral and metaphysical philosophy is held by Professor Chandler, and the one of chemistry by Professor Brodie. When certain funds become available there are to be two more, one appropriated to mineralogy and the other to physical geography; but many years may elapse, I believe, before the latter two are established; each is endowed with an income of 600*l.* a year.

3384. How is it that those professorships have only quite recently come into action?—The endowments were created by the college ordinance in 1854.

3385. There are some Aldrichian professorships, are there not?—No, not any distinct ones now.

3386. Was not the late Dr. Daubeny Aldrichian professor?—Yes; but that professorship is changed into the office of a demonstrator, who is the assistant to the professor of chemistry in the museum.

3387. The Sedleian professorship is also a university professorship, is it not?—Yes, that is the one which I hold.

3388. The Lee's readerships to which you referred are Christ Church professorships?—Yes.

3389. And, therefore, they have no connexion with the University as such?—No.

3390. Are there any other professorships connected with the University besides the Savilian, the Sedleian, and the Waynflete at present; I am speaking now of scientific professorships?—Besides the Savilian, the Waynflete, and the Sedleian, there are the professorships of geology, held by Professor Phillips; of mineralogy, by Professor Maskelyne; of zoology (founded by Mr. Hope), held by Mr. Westwood; of physiology, by Professor Rolleston; of experimental philosophy, by Professor Clifton; and the professorship of medicine, which Dr. Acland holds, making 10 altogether.

3391. And in addition you think that one is wanted for applied mechanics?—My opinion is that one more is wanted for this department.

3392. You have alluded to retiring allowances for professors. Are there any means, do you think, of connecting fellowships with chairs, which would provide such retiring allowances?—That appears to me to be the source most easily available for the purpose.

3393. Do you see any mode of making such arrangements which the University itself is likely to carry out?—That would be a matter for the colleges, and not for the University.

3394. (*Dr. Sharpey.*) Do any considerable number of your science students become teachers in schools?—Yes, many of them; and the demand is larger than we can supply.

3395. The teachers in schools no doubt combine natural science with some other branch, such as mathematics?—They generally seek to get mathematics and general science combined.

3396. Do you expect that the number will largely increase of science teachers who have been prepared in Oxford?—Yes, I do.

3397. (*Professor Huxley.*) I noticed that you expressed a strong opinion that persons taking scientific degrees in the University should at any rate have had a preliminary training in literature?—Yes.

3398. Do you not think it equally desirable that persons taking a literary degree should have had an equivalent preliminary training in science?—My opinion is that the elements of science ought to be known by all.

3399. Do not you think that persons who are to devote themselves to literary pursuits would, in most cases, be distinctly better for something more than a knowledge of scientific facts, namely, the knowledge which arises from scientific training and method?—Yes.

3400. Might it not be desirable in any preliminary examination, before taking a degree, whether on entering the University or after the first year, that

there should not only be required a certain amount of literary knowledge, but also a certain amount of scientific acquaintance?—Abstractedly it might be so, but I doubt whether it is practicable at the present time.

3401. I apprehend, however, from what you were telling us just now, that the public schools are rapidly altering their arrangements, and are preparing to meet the demand for scientific teaching, and after a few years may it not be that they will be prepared to supply a demand of that kind on the part of the University?—Yes, I certainly think so.

3402. But, quite apart from practical considerations, I presume that abstractedly you consider that a very desirable thing?—Yes, undoubtedly.

3403. I once put the question to a number of distinguished graduates of one University, in fact the University of Oxford, whether it was possible, and I was informed it was so, for a man to obtain the highest honours which Oxford has to give at present without ever having heard whether the earth goes round the sun or the sun round the earth. Would you say that that was the case?—Yes, the highest classical honours may be obtained without any knowledge of that kind at all.

3403*a*. In speaking of what the University does for science, I think I judge from your reply that about one-tenth of the income may be said to go for scientific purposes. Ought not there to be added the interest upon the 100,000*l.* sunk out of the University income; for it is clear that if that sum had been retained by the University it might have been as much as 3,000*l.* or 4,000*l.* income?—Yes; but the University has also spent large sums of money on objects not scientific, for instance, upon a new park, and you must add the outlay on these to the other side of the account.

3404. What I want to ask is, whether any corresponding expenditure of 100,000*l.* on buildings for literary purposes, for the literary side, if I may so say, has been made within the last 10 years?—A large outlay has been made, but I cannot say offhand how much? I think the University park cost about 40,000*l.*, and 30,000*l.* were given to the Bodleian Library a few years ago, which does not come into this account; 17,000*l.* were spent on the University Art galleries; and the University, out of its corporate funds, has founded the professorships of logic and comparative philology at an aggregate cost of 1,000*l.* a year, and has also increased the incomes of several professors. Also, three unappropriated canonries of Christ Church have been appropriated to theological professorships, the capital sum of which must be about 150,000*l.* To give a complete answer to your question would require more and more exact information than I now have.

3405. Were the canons of Christ Church that you speak of established out of the University fund?—No, out of the college funds.

3406. Do you know whether any sum corresponding to this 100,000*l.* which has been sunk for scientific purposes has been similarly sunk for literary purposes within the last 10 or 15 years?—No such sum occurs to me just at present.

3407. But nothing corresponding to this amount?—I cannot speak offhand with greater accuracy.

3408. In enumerating the professorships which exist, and which you conceive ought to exist, there was one modification which I should like to put before you as a possible one, and that is, whether you do not think that it would be desirable to have a professorship of physiology distinct from anatomy and zoology, which constitutes morphological or physical science?—That is a question which I should leave to Dr. Rolleston to answer. It is the *principle* whether one man should be head of the department, or whether you should subdivide the department which I have spoken of: and I think it is better to keep a large department under the charge of a single chief. The question was discussed by us last year in the department of chemistry when, Professor Brodie being appointed to the Waynflete chair, the Aldrichian fund became available, and it was considered whether it

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21 July 1870.



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should not be applied to the foundation of a professorship of organic chemistry; but the result was that it was thought desirable that Professor Brodie should be the head of the whole department, and that the lectures on organic chemistry should be given by him or by his demonstrator under his superintendence.

3409. There is an enormously greater difference in the nature of the subject matter between the physiological and the morphological parts of biology than there is between organic and inorganic chemistry; for example, a man may be a first-rate anatomist and a first-rate zoologist without a conception of mathematics, without a notion of experiments, and without, if I may so put it, a knowledge of cause and effect, as far as that goes, whereas physiology and the application of physical chemistry, though the two things may pass under the same name, are as absolutely different as can be. Therefore I think the parallel of the two divisions hardly applies?—I know so little practically about this matter that any opinion which I should give would not be of any value.

3410. There is a professor of botany, is there not?—Yes.

3411. And a professor of physical geography prospectively provided for?—Yes. With regard to the professor of botany, his collections are not in the museum, and he does not lecture there. There is no professor of botany connected with that institution.

3412. Is it not a pity to cut out that division from the professorships of physical science?—I think it is; and I have no reason to think that there would be any insuperable obstacle in the way of its being taken into the museum. At present, however, the Botanical Gardens are a considerable distance from the museum, but some alteration will be made in the course of the next year. The gardens are held under lease, and the lease has only a few years to run.

3413. (*Sir J. Kay-Shuttleworth.*) By these large expenditures of funds and annual appropriations, and likewise by the institution of the faculty of science, the University has opened the door for the access of students for the study of science, but I understood you to say that the resort of students is not as yet great?—The number of students in physical science is not large at present, but it is increasing.

3414. Is it not therefore clear that the feeding power of the public endowed schools of students for the University requires to be adapted to the improvements which have been made in the University itself?—I do not see that that is a necessary consequence, however desirable it may be; boys may be taught in schools, and go elsewhere. There are two circumstances which keep them away from Oxford. We have not taught them what they want to learn, and we have taught them what they do not want to learn. We do not teach them, because we have not insisted upon chemistry and elementary mechanics being taught; but we have taught them Latin and Greek, which the people in the most populous districts and in the north of England especially do not care about.

3415. But now that you have founded the faculty of science, and established a museum and laboratories for instruction in science, if students do not resort to you in proportion to the advantages offered, it cannot be altogether the fault of the University in that particular?—Certainly not; supposing the University to deal fairly with such students, and to open to them all the emoluments and honours which have heretofore been too much restricted to proficiency in other branches of knowledge.

3416. Supposing, however, that there should be in the constitution of endowed schools throughout the country a great change, by which youths would be prepared to enter into the faculty of science in the University, that would by so much facilitate the operations which have occurred within the University itself?—Yes.

3417. But you still apprehend that there would be a great barrier to the resort of such students to the University if scholarships and exhibitions were not

much more freely offered to such students?—I think so, but I would not wish to be misunderstood upon that, because one knows the feeling of many persons; and I think that if there is a larger demand for the study of natural science, the number of students will increase, and that more scholarships will be given for proficiency. Thus knowledge and the number of scholarships will re-act as cause and effect, one upon the other, I think; and, therefore, as far as one can judge from the very liberal way in which the University has given 200,000*l.* from its funds for natural science within the last few years, you may infer that they will act in an equally liberal way in future; and from the way in which the colleges have increased the endowments of the professors, and have received professors into their bodies, I think that the colleges may be expected, as far as they legally can do so, to act in an equally liberal spirit. But the colleges are very much tied up, and if much is to be done there must be parliamentary interposition.

3418. What I want to bring out is an expression of your opinion whether there ought not, seeing the great liberality of the University, to be some corresponding action out of doors in the public schools, and whether, if that occurred, we might not reckon upon the further developed action of the University to meet it?—I think it most desirable that the teaching of many of the endowed schools should be directed along the line of physical science; and I do not doubt that the action of Oxford will be quickly found in correspondence with it.

3419. Besides which, I understand you to say that the colleges need to be empowered by parliament to apply their funds in correspondence with this public activity towards the cultivation of physical science?—I think so.

3420. In that case, I apprehend that looking to the general feeling, of which we have had abundant evidence in the University, the proportion of scholarships annually available for students of physical science in endowed schools would be very greatly altered?—Yes, I think so. I think that a very fair number of the scholarships that are now given for proficiency in other departments might be very well, and ought to be, awarded to students of natural science; both as prizes and as inducements to future study.

3421. You must perceive how that will operate on the persons of limited incomes in the country who are desirous to give their children the best education, but who in selecting a school for their children look naturally to the means which scholarships and exhibitions will afford them to prosecute their education in the University after they leave the school, for if there be at present a great disproportion in the scholarships for literary as compared with scientific attainments, that must operate very powerfully upon professional men of limited incomes in selecting a course of study for their children?—No doubt of it.

3422. (*Mr. Samuelson.*) I understand you to state that you think it is desirable that the scientific instruction to be given at Oxford should be generally purely scientific as distinguished from professional and technical. In desiring to found a chair of engineering, do you consider that you are making an exception from that statement?—I do not, as I endeavoured to explain to Professor Stokes; I did not mean professional engineering with all its details, but the theory and general outlines of applied mechanics.

3423. Will you state what class of persons you would expect to study applied mechanics at Oxford; would they be persons intending to devote themselves to engineering as a profession, or teachers?—Not these persons exclusively, although probably there might be some students of both classes, but I mean persons who would study the principles of machines and structures as a branch of a liberal education, and as what a well-informed person ought to know, and without any view to professional employment.

3424. You would not expect any large number of those studying applied mechanics to do so with the intention of giving a professional application to the



study?—I would not exclude them. I believe that there would be some persons who would do so.

3425. How and when would you expect those men to obtain the necessary professional training?—I think they would have to get it after leaving the University; much in the same way as a barrister who may read the elements of law in Oxford goes to a barrister's chambers to learn the practice; or a man who has passed through a medical course in Oxford must come to the hospitals to learn the practice; so would a student, who is going to be a professional engineer, learn the elements of theoretical applied mechanics in Oxford, and go to some workshop afterwards to learn the practical part of it.

3426. That would involve, would it not, the necessity of a young man, who would be at least 21 years of age, going through a professional training at a subsequent time?—The tendency of our students now is to matriculate at an earlier age than formerly. Many students now come up who are not more than 17 years of age. The age of young men coming from public schools is, I think, increased; and the reason probably is that the large public schools find it to their advantage to keep boys at school longer than they used to do, viz., until they are 19 years of age; but in the smaller schools they do not keep them so long. Moreover, our course of study now may be completed in two years and nine months—under three years; many of the students preparing for professions may be ready to leave by the time they are 19 years of age, after having taken their degrees.

3427. And of course their being able to take their degrees would be very much facilitated if the examination for those degrees were not so advanced in respect of literature?—Yes. And there is another important point again to be considered in this matter. I believe, that a student who is preparing himself for a profession, say, that of an engineer, if he has gone through the University course of mechanics first, will learn a great deal more of his strictly professional knowledge, and in a superior style, in a much shorter time, than another man who has not gone through such a theoretical and preparatory training; the latter has acquired a knowledge, but it is a different kind of knowledge.

3428. Upon the whole would you expect that professional men, or men devoting themselves to civil or mechanical engineering, would form a large proportion of your students?—No, I do not think they would ever form a large proportion.

3429. You would rather look for men who would become teachers, or who would wish to include the study of applied mechanics within the general range of instruction which they would get?—I think it likely that those two classes would make by far the largest part of the attendants on lectures of that kind, at least, at present.

3430. You are adverse to entrance or matriculation examination?—Yes.

3431. And your reason was this, that it would exclude many men who otherwise would fairly benefit by University instruction?—Yes.

3432. Would you consider that the same objection would apply if a longer notice, say five or six years' notice, were given that at some subsequent period a matriculation examination would be required?—Yes, because many young men and boys have not, at present at least, the opportunity of acquiring the desired information: they are placed where they cannot get it. It is not the deficiency of will but the deficiency of proper, and in many cases of any, schools near to the places in which they live, where they can obtain the necessary education. I can speak from experience upon that. I have known cases of it.

3433. Then, in point of fact, to a certain extent that is turning the University into a secondary school?—It may be so; but I should not quite agree with that interpretation of the circumstance, and for this reason, I should think that the students who would come to Oxford under these circumstances would rather be

older than the generality of the students, or of a more than ordinary capacity.

3434. You would rather say that the advantages would be derived by boys or young men who had received some secondary education, but which education had not been so complete as it ought to have been?—Well, that may be the case.

3435. (*Professor Huxley.*) You are doubtless aware of the nature of the matriculation examinations of the University of London?—Yes.

3436. That examination I am informed is as severe as the moderations at Oxford?—I have no means of comparing the two; I know the one, but I do not know the other.

3437. At any rate it is quite certain that a very large number of English boys, of ages from 16 to 18, or thereabouts, are prepared in some way or other so as to be able to pass the matriculation examination of the University of London very successfully?—But can you tell me what the per-centage of rejection is?

3438. I know it is very large.—Then I ask, What means have we of comparing the University of London, which is a place of examination only, with Oxford, which is a place of education? I should be very sorry to see its character as a place of education altered, but I should be very glad to give every facility for students to come.

3439. My question was directed not towards the advisability of that process or of any other, but only as to the possibility of having English boys, even with the abominably bad primary education which exists now, properly prepared for such an examination as that by the age of 17?—I should wish to bring up to Oxford as many students as possible; and my objection to a public entrance examination is, that it would exclude many who now come up, and make an excellent use of their time at the University. They would be excluded by reason of their not passing that examination; whatever matriculation examination you have you could not sink it sufficiently low to include them, unless you included a number whom it would be very undesirable to admit.

3440. (*Dr. Sharpey.*) Has that been from the want of advanced schools?—Yes.

3441. (*Professor Huxley.*) Do you think that that occurs to any extent, or that it ought to occur if our grammar schools were at all what they ought to be, amongst the class of people who can afford to send their sons to the University?—If our grammar and other provincial schools were improved, it would not occur to the same extent as at present; for the persons I am speaking of are for the most part sons of professional gentlemen with small means, persons who value the higher education, and have not the means to procure it for their children.

3442. But that I presume does arise from the circumstance that the education in the grammar schools is simply in many cases abominable and scandalous, and if that education were proper and good that difficulty ought not to exist?—No doubt; but here we shall be met, at present at least, by another difficulty, viz., the supply of competent teachers is small, and that supply will very soon be exhausted, and I fear that when you have done all you can to improve your schools, you will not have much improved your education, at least at present; intellect is of but a limited amount, and you cannot much increase it.

3443. Truly; but surely the entrance examination which we are talking about now is not such as to require anything like an out of the way intellect?—No, that is true; but I am referring to teachers. You would not raise much the average capacity of the teachers in schools, and that evil is one which I think a matriculation examination would tend to exaggerate rather than to diminish, by keeping a number of those persons out who would come in and profit by the instruction. I do not wish to throw any bar in any way to their coming. I would remove as far as possible all obstacles in the way of entrance into the University as a place of education.

3444. Although I agree with you as to the difficulty

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21 July 1870.



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31 July 1870.

with regard to the average capacity of teachers, do not you think that it is possible to do the other thing, and diminish their average incapacity?—Yes.

3445. (*Sir J. Kay-Shuttleworth.*) May we not look to the scientific department of the University for the education of a class of teachers who will be diffused over the country?—Yes, I think so; but that is to a great extent a question of pounds, shillings, and pence, whether you can make it worth their while to devote their lives to scientific teaching.

3446. But supposing it could be made worth their while, may not the country naturally look to the scientific department of the University for the production of teachers for those offices?—Quite so.

3447. (*Mr. Samuelson.*) Your object is to avoid excluding persons who might benefit by scientific instruction at the University?—Yes.

3448. In accomplishing that object do you not run some risk of depriving the secondary schools both of the check and the encouragement which a more stringent matriculation examination would imply?—I think not, because you would get an examination at the end of the first term, or some other very early time in the course. I should thereby stop students. There is one other remark which I should like to make, which is an important fact to bring under the notice of the Commission, and that is that within the last two years we have thrown the University open to unattached students, that is, to students not belonging to any college or hall. A question was raised as to the cost at which those men were able to live, and we have just received the returns freely made by the men themselves, and the average for the lowest ten comes to 47*l.* 10*s.* per annum, and that 47*l.* 10*s.* includes 10*l.* and odd for their tuition fees. Thus the living, including lodging and boarding, costs 37*l.* I gave evidence to a Committee of the House of Commons three or four years ago upon that subject. I then thought that it could be done at as low a rate as the average shows, for I had evidence from men who had been pupils of my own, but great doubt was raised as to whether it was possible. However, those men have lived in the University, and the returns give the average which I have mentioned. Of course they are not there for more than 26 weeks in the year, and some of them live under 1*l.* a week. They take their own lodgings, and provide food for themselves. Now if a number of scholars ships were awarded for natural science and mathematics in close connection with the museum, either by the colleges or in any other way that you may recommend, with the option to the scholars of either living within a college or outside, you would offer a great inducement to young men of small means and good capacity to come and study those subjects with the prospect held out to them of being engaged in instruction in schools afterwards, and of earning a competent livelihood.

3449. Is the University taking any steps to make it known how cheaply those young men have lived?—The report to which I have alluded will be published in a short time.

3450. You have spoken of leaving the greatest possible freedom to studies. Is there any experience within your knowledge in other universities here, or abroad, which would give countenance to such a system?—I know nothing about foreign universities.

3451. Upon what grounds do you base that recommendation?—Because I find that many persons who would come to the University do not come because the course of instruction is limited to certain subjects, and does not include that which they require.

3452. You do not expect that that freedom would involve any essential drawbacks?—I do not know in what way it can, if the *general* training is good. I conceive that you can train and exercise a student's intellect as well in natural science as in mathematics or classics, when it is properly taught.

3453. You mean taught as it ought to be taught, and would be taught in the University of Oxford?—Quite so.

3454. (*Marquis of Lansdowne.*) You admitted that it was possible for a man to take the highest honours in the University, and yet be in total ignorance of the commonest rules of physics. Would any of the modifications which you have suggested obviate that?—I have not entered fully into that question, and have not suggested any scheme of general training. The question put by Professor Huxley to me would modify it.

3455. You do not recommend forcing men who go into a course in classics, we will say, to pass in physics?—I have not ventured to recommend it, at present at least.

3456. Should you say that such a thing would be advisable?—Abstractedly I think it is.

3457. (*Chairman.*) Could a man get a degree at Oxford without any mathematics?—Nearly so; he need do no more than a little arithmetic, and Euclid or algebra at his "Little Go."

3458. I believe that about 7,000*l.* a year is paid by the University of Oxford in stipends for examiners and professors. Are you able to give a rough idea how much of that is applied to classics, and how much to other branches of knowledge?—Not offhand.

3459. I see that a certain amount of money is paid by the University in the shape of pensions and annuities; are those pensions paid to the University officers?—Chiefly to discharged University officers.

3460. Then nothing has been done at the University of Oxford which establishes the principle of granting provision in the shape of pensions for retirement?—No, nothing at all.

3461. (*Dr. Miller.*) How many persons matriculate in Oxford annually?—The matriculations for the year ending October the 10th, 1869, were 603. I think this year the number is rather less.

3462. Perhaps you do not know that 381 passed the matriculation examination of the University of London last year and the year before?—No, I do not; but you must remember that the University of London is an examining body, and Oxford is a teaching body.

The witness withdrew.

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HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S., examined.

3463. (*Chairman.*) I believe you are Savilian Professor of Geometry in the University of Oxford?—Yes.

3464. Will you explain to the Commission how far the relation of university teaching, and of tutorial teaching, in the case of mathematics, differs from their relation to one another in the case of the natural sciences?—The colleges provide much more teaching in mathematics than they do in the natural sciences. There are only three or four colleges that give any systematic instruction in the natural sciences, but every college has a mathematical lecturer, and the teaching given by these lecturers is usually very good.

3465. Does the teaching by the professors differ in any essential points from the teaching given by the tutors in the colleges in mathematics?—I think that

it does, and that it ought to do. The teaching in the colleges is necessarily somewhat of a schoolboy kind, not that it is confined within very narrow limits, but it is kept close to text books, and close to the purposes of the University examinations, and by itself it does not always have a very awakening effect upon the intelligence of young men; it is apt to have something of a "grinding" character.

3466. Do a large number of the more advanced students attend your lectures?—I think that nearly as many as read for honours in the University attend the lectures of the mathematical professors, but the number that read for honours is not large.

3467. How many go out annually in mathematical honours?—I should say that 20 is a favourable estimate.



3468. Is the number increasing?—Slowly and slightly, but it is increasing. The quality of the mathematical education given in the University has improved considerably in the course of the last 20 years.

3469. Is that owing to improved teaching in the colleges?—Partly to that, and partly to the greater activity of the professorial system.

3470. How many mathematical professorships are there in Oxford?—There are three altogether, the two Savilian Professorships, and the Sedleian Readership held by Professor Price. The Savilian Professorship of Geometry, which I hold myself, was founded as a professorship of geometry, but it has now assigned to it the whole domain of pure mathematics, without exception, and that is a field which it is impossible for any one professor to cover in his lectures. The consequence is, that I have found it advisable to limit myself to geometry, and there are at present no public lectures given in any other part of pure mathematics, but geometry.

3471. Do you think that the establishment of another chair of pure mathematics is much wanted?—I do, indeed; if the mathematical education given at Oxford is to be further improved in quality, such an addition to the professorial staff ought certainly to be made. Mr. Scott Russell, in his work on Technical Education, assigns no fewer than four professors to the subjects represented by pure mathematics. That may be an extravagant estimate, but I am sure that one is not enough.

3472. What are the emoluments of your professorship?—The two Savilian professors are exactly on the same footing; their emoluments are derived from an estate left by Sir Henry Savile, which gives then 300*l.* a year each, and they will eventually receive an augmentation of the same amount from the revenues of New College.

3473. Does the University itself make no contribution from its chest?—The University has for the last seven or eight years augmented the stipends of the Savilian professors by the payment of 100*l.* annually, but this augmentation is now ceasing, in consequence of the commencement of the payments by New College.

3474. Is the New College payment to begin very shortly?—New College will pay 150*l.* per annum to each Savilian professor for the next five years; after that time this payment will be doubled.

3475. Are you bound to deliver any fixed number of lectures during the year?—Yes. The Savilian statute prescribes 24 public lectures in the year, and 16 of a more private character; so that the statutable duties are not very onerous. Many more lectures are generally given by the professors than the number prescribed.

3476. Is admission to your lectures confined to students at the University?—No; but, except in very rare cases, it is not sought by others.

3477. What are the duties of the Savilian Professor of Astronomy?—His duties, as assigned by statute, are the same, in respect of the number of lectures, as those of the Savilian Professor of Geometry. It has always been felt by our Savilian professors of astronomy that they ought, if they could, to give a certain amount of practical teaching in astronomy, but hitherto the resources at their disposal for this purpose have been extremely small. There is at present only a small transit instrument and a small azimuth instrument, placed in an inconvenient building and in an inconvenient situation, and certainly some further appliances are much needed. The long-continued illness of our late excellent Professor of Astronomy deprived us of many of the advantages which we should otherwise have derived from his great genius, and his earnest devotion to the interests of science and the University. The study of astronomy has, in consequence, very much languished among us for the last few years, owing to its being a subject in which the colleges do not provide any teaching, and

which is thus left entirely dependent on the lectures of the professor.

3478. Has it ever been contemplated to improve the observatory, or to remove it from its present position?—When I speak of the observatory, I do not speak of the Radcliffe Observatory, which is not under the control of the University, and has no educational duties annexed to it at all. We have frequently talked of obtaining a large telescope adapted to the use of students, but I do not think the matter has ever got further than conversation. It is quite time that something was done in that direction.

3479. With respect to the Sedleian Readership of Natural Philosophy, do you think the number of subjects assigned to this chair too large?—I do. I am afraid that I differ from some of my friends on this point, but, considering that all the applications of mathematics to natural phenomena (with the one great exception of astronomy) are assigned to that chair, I think the amount of ground too great for one man to cover, and the consequence is, that we cannot expect from the professor lectures on such subjects as the mathematical theories of heat or of electricity.

3480. The range of subjects you consider to be too great for one professor?—Certainly, if he has to lecture on the whole of the mechanics of solid and fluid bodies, and, in addition to them, on the theories of acoustics, light, heat, and electricity. I confess that I should like to see the very important educational subject of mathematical mechanics separated from what one may call mathematical physics, simply from the feeling that we should thus obtain more lectures, and that we want more lectures.

3481. You do not regard the scientific school at Oxford as in any respect a technical school?—Certainly not at present, it is not so in the least.

3482. And do you think it desirable that it should assume more of that form?—I think that the University might render much more important services to science than by trying to become a technical school. We should have to begin at the very beginning to make ourselves into a technical school; and I cannot but think that by trying to make ourselves into a school of pure science we should render more important service, both to the higher education, and, really, in the last resort, to technical education itself.

3483. How far at present do you consider Oxford to be a place for men engaged in original work?—Not to any very great extent. It is much more so than when I first remember it, but even now there is somehow not a sufficient inducement to the young men who remain and reside in the place to devote themselves to original scientific research; as yet there is not enough of such a spirit in the atmosphere of the place.

3484. Have the professors too much to do, as professors, to be able to devote much of their time to original research?—That is the case with some of them; it is certainly the case with the Professor of Experimental Philosophy, and with the Professor of Physiology. The Professor of Chemistry is, perhaps, better supplied with assistance than either of the other two professors.

3485. If Oxford once became a place in which much attention was paid to original discovery, do you think the tendency would be in students to devote themselves more to discovery than is the case at present?—I think so. There are signs of this spirit already beginning, not only in scientific studies, but I should say even in the direction of classical learning as well. The rising generation show a greater tendency towards original research than was the case formerly.

3486. You have told us already that you consider a certain number of additional professorships desirable; is it your opinion that in other departments of knowledge additional professors are required?—I am clearly of that opinion.

3487. In what departments would you like to see further appointments?—I think the great departments of physiology, and chemistry, and physics are all three in need of strengthening in this manner.

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21 July 1870.



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3488. You would subdivide the subjects themselves, would you not?—Yes; I believe that to do so would, on the whole, be for the interest of the University. You would not only gain in this way the presence of a greater number of eminent men, but you would make the work lighter for the professors themselves, and you would diffuse a stronger atmosphere of original research and inquiry.

3489. Certain professors are allowed the assistance of sub-professors or demonstrators, are they not?—Yes. Demonstrators seem to me to be absolutely necessary where practical work is a part of the duty of the professor. You cannot expect a man of eminence enough to be made a professor, to devote six hours a day to the superintendence of the details of laboratory work, and, therefore, a sufficient number of demonstrators is indispensable. With reference to sub-professorships, I confess that I should rather like to see independent lectureships appointed, and given to distinguished young men, to lecture on particular and special branches of science in which they have distinguished themselves, or for lectures in which there was a special need felt at the time. I have great doubts as to the system of head professors and sub-professors under them working satisfactorily. If the sub-professors are really intended to act in subordination to the head professors, I have great doubts whether such a system would work harmoniously in a place like Oxford.

3490. You, therefore, would certainly prefer an increased number of professors?—I should like to see, where that is possible, an increased number of professors, but I admit that I should also like to see lectureships, with definite duties, of the kind I have mentioned.

3491. Might the sub-professors be supplied from the colleges?—I should hope that hereafter there might be no great difficulty in getting that done.

3492. (*Professor Huxley.*) Do you think that that arrangement could be made to fall in with the disposition of the fellowships?—I think that it might do so, and that it might enable you in some cases to get over the difficulty of the fellowships, by assigning to some of the fellowships such duties as those of lectureships or demonstratorships.

3493. The holders of fellowships under those circumstances would be a sort of *professores extraordinarii*?—Yes, they would be, generally speaking, young men, and they would be in a position to enable them to win their spurs, and afterwards, perhaps, to obtain promotion to higher places in the University.

3494. (*Dr. Miller.*) Do you see any difficulty in the working of it, the one being a University office, and the other a college office?—I think not, if there is an equitable statute framed between the college and the University, to regulate the duties of the lecturer. It would be requisite that those duties should be agreed upon, and a fair arrangement come to, but I do not think that there would be any difficulty in it.

3495. (*Chairman.*) You have stated that you think it desirable that Oxford should become more a place for original research than it is at present; should you like to see any professor without any duties as to lecturing?—No, I think that such an exemption would be positively injurious to the professor himself, as well as to the reputation of science. And, in addition, one great object of having eminent professors resident at Oxford is, that they may be brought into contact with the young men, and the best way of ensuring such contact is to impose on the professors the duty of lecturing.

3496. It is your opinion, is it not, that the colleges ought to continue to be educational bodies, and that their educational functions ought not to be concentrated in the University?—I was brought up under the college system, and I cannot help believing that upon the whole it is desirable to retain it, and that what you have to do is to harmonise the two systems with one another, and not to abolish either of them.

3497. Can you explain to us, a little more in detail, what you think are the advantages which result from

the college system?—I think that as you have great buildings, you would always wish to keep them as common residences for students; these common residences would have to be under some kind of discipline, and I do not think that such discipline can be effectually managed except by persons who command the respect of the young men as their teachers. I do not believe that a system of supervision by *deans*, as we call the disciplinary officers, would ever answer. I think that you ought to combine within the colleges disciplinary and teaching functions, and that if you do not do so, you would be throwing away great opportunities of usefulness.

3498. Would you like to see any changes brought about in the tutorial instruction of colleges?—It seems to me that as the professorial system develops, both in the literary and the scientific directions, the tutorial teaching must assume a position, in a certain sense, of subordination to it. That is to a certain extent the case already, and I have no doubt that such a state of things would naturally come about. For instance, the education of young men cannot be carried on by lectures only; they must have exercises to write, and examination papers given to them to see how they can do them. You could hardly expect a university professor to undertake such duties; they would absorb an enormous quantity of his time. All such detailed instruction must be done by a kind of *repétiteur*, and I cannot say that any class of persons are better suited for work of this kind than the persons that you can find in the colleges.

3499. Are college examinations established in all the several colleges?—Something of an examination system is established in all the colleges, but in entire subordination to the University examinations.

3500. Is there any examination in natural science in any of the colleges?—Hardly in any; the number of students is really so small, that the colleges have not turned their attention to organising terminal examinations for them.

3501. With respect to the payment of the professors, do you think that that ought to be chiefly provided by endowment?—In Oxford, I think, certainly. Nearly every one is paid by endowment in Oxford, and it would seem hard to send one set of persons to fish for themselves, by means of fees, when every one else is paid in another manner. At present many of the professors do not take the fees to which they are entitled.

3502. The University at present has not the means, has it, of greatly increasing the endowments of the professors?—I should say certainly not at present; and even if the disposable funds were greater than they are, the University would probably remember that there are other claims of a professorial kind upon them besides those for professorships in natural science, so that if there is any margin remaining, I think it very doubtful whether that margin would be secured or ought to be secured for natural science.

3503. If anything more is to be done in that direction, it must be done by the colleges, must it not?—Either done by the colleges, or, at any rate, out of funds provided by them.

3504. They already, we understand, do give a certain amount of assistance towards making up the stipends of the professors?—Yes, they do.

3505. Do you think that that might with advantage be extended considerably further than at present?—I should certainly have thought so, and without any injury to the interest of the colleges as places of education. Many of the colleges are distinctly overburdened with fellowships; they have more of them than can be disposed of advantageously.

3506. Have you an unfavourable opinion generally of the principle of non-resident fellows?—I think that we want some non-resident fellowships as rewards. The system of non-resident fellowships has proved, no doubt, a most powerful stimulus to education; but we have a number of them out of all proportion too large; so much so, that I am quite sure that it occasionally happens that persons are



elected to fellowships who fall a little below the high standard of attainment which such a distinction should imply.

3507. Are the majority of the fellows at present non-resident?—Yes, I believe so.

3508. Do you think that the number of fellowships granted as mere rewards might be considerably diminished?—Unquestionably, and the proceeds of the suppressed fellowships might be applied to the payment of educational officers, either in the colleges or in the University.

3509. Are you able to give us any rough idea of how many fellowships you would like to see still continued, to be looked upon mainly in the light of rewards?—I think, roughly, we have at present between 20 and 30 a year vacant, and I am disposed to think that 10 a year would be enough for the purposes of educational rewards.

3510. Do the stipends paid to the Oxford professors differ materially one from another?—The divinity professors (with one exception) have greatly the advantage of their brethren, otherwise I think that you might say that the professorships are intended to be, and that they will eventually come to be, worth about 600*l.* a year.

3511. Are you able to say what you think is an adequate endowment?—I should have thought, perhaps, if you went half way between 600*l.* and 1,000*l.* it would give a very fair amount. If, taking the average of 600*l.* a year, it became the rule that every professor should in addition be a fellow of some college or another, you would obtain an income that might be regarded as adequate.

3512. Something has been done in that direction already, has there not?—In certain cases it has been done.

3513. With regard to the appointment of professors, are they appointed all by the same board?—No; they are appointed in the most various manners.

3514. Is the appointment at present in a satisfactory position?—I should say not quite satisfactory. I do not think that the scientific world has any confidence that the best man will in every case obtain a vacant place.

3515–6. Who are the electors to your professorships?—The original electors appointed by Sir Henry Savile are, the Archbishop of Canterbury, the Lord Chancellor, the Chancellor of the University, the Bishop of London, the Home Secretary, the two Chief Justices, the Chief Baron, and the Dean of the Court of Arches. In former days that board made most excellent appointments, and Sir Henry Savile's selection was amply justified. The warden of New College has now been added; but science is not directly represented on the board.

3517. Can you give us your views as to how an electing board should be constituted?—I should certainly wish an electing board not to be a large one, so that there might be a sense of responsibility attaching to the individuals composing it. I should like to see three elements represented upon it; first, the local scientific element, on account of the keen interest which scientific men resident in a University are sure to take in the appointment of those who are to be their fellow workers; secondly, I should like to see the outside scientific world also represented upon such a board, and, thirdly, I should wish to see some impartial and simply business-like element also present. A board so constituted would, I believe, work well. A purely local board would be objectionable on account of the difficulty of passing over local claims.

3518. Do you think that the professors themselves should have seats in the electing board?—I think that one or two of the local professors ought to be upon every board, but I do not think that they should form the majority of any board. I ought to explain that I should not wish to have one and the same electing board for all professorships. I should have different boards for different groups of professorships.

3519. Have you observed any special dangers at

Oxford in the appointment of professors?—There is a feeling that the ecclesiastical element is too predominant in some of the electing boards. We none of us would wish a scientific board to make ecclesiastical appointments, and we feel that, on the same principle, an ecclesiastical board is not always the best to make scientific appointments. There exists in this direction a special source of danger which I do not think ought to be incurred.

3520. Are you satisfied with the present distribution of rewards in the shape of fellowships and scholarships, as allotted to different subjects of study?—In one sense we have nothing to complain of. I do not think it has happened that more than one or two, at most, either of mathematicians or of natural science students, who thoroughly deserved a fellowship, have as yet failed to get one. But there is a great uncertainty about the vacancies. Sometimes two years pass without a single fellowship being offered for either of those two subjects, and sometimes the vacancies come rather more frequently, I will not say that one could wish, but certainly somewhat too frequently in comparison with the dearth which has preceded.

3521. Is there usually much competition for science fellowships?—Not amongst a large number of men, but amongst a small number of good ones, say three or four.

3522. (*Professor Stokes.*) Are there any provisions in Oxford for enabling professors to retire when they get to an age at which they can no longer discharge efficiently the duties of their professorship?—In most of the professorial statutes there is a clause inserted, empowering the Vice-Chancellor, in case a professor should become incompetent from ill health to discharge his duties, to appoint a substitute, and to assign to him what share he may think equitable of the professor's stipend. This is the only such arrangement that exists. There is nothing of the nature of a retiring pension, and it certainly would be a great advantage, both to the professors, and, what is more important, to the University, if a system of retiring pensions could be arranged.

3523. In the case of a professorship that is partially endowed by means of a fellowship in some college, is it not the case that the tenure of the fellowship depends upon the professor retaining the professorship?—Yes, when the fellowship is annexed to the professorship that is the case, but in some instances a college of its own liberality has made a professor a fellow, and in that case the answer to the question would depend upon the statutes of the particular college.

3524. Supposing a professor is married, is he able to retain his fellowship?—I believe that, without a professorship, in all the colleges at Oxford, marriage would vacate a fellowship, so that if a married professor, still remaining married, ceased to be a professor, he would thereby lose his fellowship.

3525. Then in such cases, the only provision on which the professor could retire is a certain fraction of that part of the endowment which is irrespective of the college fellowship?—Yes, I believe that is the state of the case.

3526. Do you think that that is sufficient for the purpose?—No, I should have thought it would be better to have some system of retiring pensions so arranged as to enable the incoming professor to receive at once the full income and the full emolument. You elect under great disadvantage, if you have to elect your new professor to a stipend encumbered with a pension, and if he has to wait till the pensioner has died.

3527. In the case of a professorship which is not by statute connected with any fellowship, but for which there is merely a chance that a college will elect the professor, do you think that the uncertainty of the endowment being augmented thereby may be a bar to a first-rate man taking, or being a candidate for, a professorship?—I am inclined to think so; I believe that if the professorships at Oxford were always combined

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with a fellowship in a college, they would be even greater objects of attraction than they are. I would say nothing against their attractiveness at present, but I think they would become even more attractive than they are. It certainly is extremely desirable for any resident at Oxford to be connected, as a fellow, with one of these great corporations. It gives him a great additional interest in the place, in its studies, and in its pursuits, and, in addition to its money value, it adds greatly to the value of his position. I think it a distinct disadvantage to a professor to be entirely outside of the college system.

3528. Do you consider that uncertainty as to whether the endowment would be augmented by election to a fellowship prevents so many men from outside the University becoming candidates as otherwise might be the case?—I certainly think it must, in so far as it considerably diminishes the value of the inducement which you offer, for there is the greatest uncertainty whether any college will confer a fellowship upon a new professor.

3529. (*Dr. Miller.*) I think I understood you to say, that you do not consider that at present Oxford is a very favourable school for original research in science?—Not very favourable, certainly.

3530. Are you prepared to make any suggestions as to the mode of improving that position, independently of giving more time to the professors?—I would give more time to the professors, by increasing their number; and I would render, as far as possible, the University laboratories available to young men after they have taken their degrees and have obtained a fellowship. What I regret to notice is, that young men who have attained that position, and who continue to reside in the University, do not immediately devote themselves to original research, or to preparing themselves, as well as they can, for original research.

3531. Do you think there is any want of funds which stands in the way of this research?—No, I do not think there is. It would, however, be very desirable that there should be a collection of University apparatus, available for their use.

3532. Do you consider that the tendency of the mind at Oxford is toward science at the present time—that there is a greater leaning amongst men to it than there used to be?—Unquestionably.

3533. Both amongst the younger men and amongst those who are in authority at Oxford?—I think both amongst the one and the other, and I should say especially amongst the younger men. I must say, that I attribute the improvement and the change in that respect to the really excellent teaching that has been given by the natural science professors during the last 10 years.

3534. Do you approve of the plan of giving degrees in science?—I have often thought that it would be desirable; but at the same time, I own, I do not attach any very primary importance to it. I imagine that our degrees are valued not exactly for the amount of proficiency which they imply, but for reasons of a very different kind. Considering what our ordinary bachelor of arts degree is, I am afraid that if we proceeded to give a degree of bachelor of science, we should hardly make it valued as it ought to be, at any rate for its own sake.

3535. Do not you think that that is a thing which if the degree were established would establish itself in public opinion?—My fear would be that you could not make the degree of bachelor of science of a very much higher standard, to compare two dissimilar things, than the degree of bachelor of arts; and unless you did make it imply a much higher standard in science than the B.A. degree implies in arts, I do not see how the public estimation of it could be very great.

3536. Is there any means, for instance, by matriculation, of raising the character of the education given. Do you think that is a mode in which Oxford might move with advantage?—I have always wished to see a matriculation examination.

3537. You do not fear the influence that that might exert upon the number that would enter at Oxford?—It might diminish the numbers for a short time, but I should look forward to a rapid increase afterwards.

3538. It would exclude, would it not, a certain class of students who come to Oxford now for the sake of social advantages and position?—I think that it would only exclude them temporarily, and that they would come better prepared the next time. I do not think that we should lose altogether any students of that class, but I think they would come to us under circumstances more favourable both for them and for us.

3539. (*Professor Stokes.*) Might it not sometimes operate to exclude very promising young men who have not had advantages in the way of education, but who would be able to make very good use of the University if they could get there?—That is a very important consideration, and I would say two things in reply to it. The first is, that the matriculation examination should offer a good deal of option, and that if a man can prove to you that he is a student at all, and that he knows anything about anything, you ought to let him in; the second is, that in all our examinations we do look out for ability and promise rather than attainment, and we do so, perhaps, to a fault. I should have but little fear that even a very rough and uneducated young fellow, if he had any energy and ability, would fail to make it felt in a matriculation examination organized in a wide and liberal spirit.

3540. (*Dr. Miller.*) To go back to the encouragement of research in science, are you acquainted with the mode in which a given small sum of 1,000*l.* every year is distributed by the Royal Society for that purpose?—Yes.

3541. Have you ever considered the mode in which the Government might best be advised in the furtherance of scientific research in that direction?—I should have thought that the Council of the Royal Society are in a position to give them better advice than any other body that I can think of at this moment.

3542. Are you contented with the mode in which that is administered now?—I do not see my way to suggest any improvement.

3543. Do you think that the sum might be increased with advantage, and placed at the disposal either of the Royal Society or any board recognised by the Government, constructed upon that model?—I should have thought it might be increased gradually, but, perhaps, not suddenly to any great extent. I should like to see a collection of apparatus of a valuable and expensive kind formed by Government, and placed by them at the disposal of scientific men for special researches; just as I should like to see something of the kind done by ourselves at Oxford.

3544. But would you construct a laboratory in anticipation of a demand of that kind, or would you create it on the request of a particular person for the means of carrying out a particular line of research?—I should be anxious to see such a collection formed irrespectively of any special request; but I should like to see additions made to it for the use, and at the request of particular persons.

3545. Do you consider that at Oxford the plan which you have adopted at the museum in any degree meets that deficiency?—Only very imperfectly as yet, but I certainly do think that we have something like the beginning of it there, and I hope that when Professor Clifton's new Institution is fairly at work, if it can be got fairly at work, it may supply the want in one important direction.

3546. (*Sir J. Kay-Shuttleworth.*) You spoke of the appropriation of college funds to fellowships and demonstratorships, is that done now in virtue of any powers existing within the colleges, or simply in the way of selection of a person to hold a fellowship or other office in the college?—If I remember right, the only instance that we have, as yet, where offices, which



you may call fellowships, are formally devoted to lectureships or demonstratorships, is the case of the Lee's readerships at Christ Church; we have no other fellowships that as yet are appropriated in that manner.

3547. You would think it desirable that such powers should be possessed by the colleges, to appropriate their fellowships to such objects?—Yes, I do, and I confess I think it desirable that they should not only have the power, but should also be compelled to exercise it.

3548. You spoke likewise of its being desirable that there should be some form of central authority representing in part the scientific body in the University, for the regulation of such appropriations of money to specific objects?—I was then speaking only of boards for the appointment of professors; but I conceive that a board framed in a similar manner would be very suitable for the purposes implied in the question. Only such a central board ought to be much larger, and any external element ought to be introduced in such a manner as not to compromise the independence of the University.

3549. Supposing that for disciplinary and other purposes, the collegiate system should continue to operate as it does now in the University, and that those fellows who have functions in the college should likewise have functions as adjuncts to the professors, would it not be desirable that there should be some such central power to regulate harmoniously their relations to the colleges, and to the museum?—I think such a body would be very desirable. We have not in existence in the University at present a body at all calculated to perform such functions, but I think its constitution by-and-by would be of great benefit to the University.

3550. I understand you to conceive, that, by the progress of scientific instruction in the University, it would be desirable that if 10 fellowships annually were appropriated as rewards for attainments of whatever character, the rest of the fellowships might be applied to the function of teaching within the University?—Yes, within the University and within the colleges.

3551. I apprehend that if the University were well fed with qualified students from the endowed and public schools of the country, and that if the number of students in physical science were by that and other means considerably increased, there would be ample work for such an appropriation of fellowships to teaching within the colleges, and in the University?—I certainly think so. It has to be always remembered, that it is not only the teaching in science that requires extension, but also in all the various branches of literature and learning; so that I am sure there would be an ample demand for any fund that became available in that manner.

3552. Your view being a double one, first that you would desire that the number of fellows non-resident and inactive should be greatly diminished, and that, for purposes both of literary and scientific instruction, the number of resident fellows actively discharging the duties of teaching should be increased?—Exactly.

3553. I understand you to say likewise that emoluments of from 600*l.* to 1,000*l.* a year are desirable for professors actively engaged in teaching at the University?—Yes, I think the higher limit is, perhaps, somewhat in excess of what is necessary; a fair estimate would lie between the two limits.

3554. If the professors were provided with a sufficient staff of demonstrators, and if the emoluments were such as to attract men of the highest position in the scientific world, would they not have more leisure for scientific research, and might not such men be expected to engage, to a great extent, in scientific research?—I certainly think so; I think that it is of the utmost importance to make these places so attractive as to command the services of the best men that can be had. I am more afraid of our not getting the best men, than of their neglecting scientific research, if we can get them.

3555. First, the contact of such minds through the medium of teaching with the youth in the University would be important, but also the fact that the students come in contact with men who were actually engaged in physical research would itself lead to an increase of the number of investigators amongst the students?—I believe myself that the second point is of as much importance as the first. It may be the most obvious duty of a University to educate the great mass of the men who come to it, but I sometimes feel that that duty is almost second to that of teaching those who will have to be teachers in their turn, and of trying to train the few who may one day become discoverers in science.

3556. The solution of this important question, therefore, lies in these several points: in the provision of sufficient emoluments to attract men of the first class, in the provision of sufficient assistants to afford them leisure for investigation, and of apparatus which could enable them to conduct that scientific research?—Yes.

3557. And the result would probably be that the University would greatly extend the number of original investigators which it educated?—That is my impression.

3558. (*Professor Huxley.*) You spoke of dividing the chair of pure mathematics, would you propose to divide the subject between your two professors by statute, or leave it to them to arrange what division they would make?—I think I should do it by statute, but I confess that I should trust any two sensible men not to quarrel over it, if you left it to them, and not to lecture against one another, nor to give two lectures upon one subject simultaneously. But, as there is a natural division, I should assign by statute to the one all the geometrical subjects, and to the other all the pure analysis.

3559. I think you stated that you thought it desirable that a similar division should take place in some other branches of science?—I do think so.

3560. Have you decided views as to which should be subdivided?—Biology is one of the branches of science which should be subdivided. At present, nearly all the biology that is taught at Oxford is taught by Professor Rolleston himself, or under his immediate superintendence; but I should have thought that you might divide the two subjects of morphology and physiology, and get two independent professors to divide the work between them. I should also wish to say, upon this point, that the Professorship of Botany is not at present sufficiently connected with the studies of the University, whether owing to the arrangements of our examination system or not, I cannot presume to say, but I am certain that our biological department is weakened by the want of the influence of the professor of botany in it.

3561. Botany being one of those subjects by which the principles of biology may be taught practically, perhaps with greater ease than any other?—I suppose that that is so; but the study of botany is too much neglected among us; and the lectures of our present excellent Professor of Botany are most inadequately attended.

3562. Can a man pass out of the science school without knowing anything at all about botany?—I have often examined in the Natural Science School, but never, of course, in the department of biology. I have, however, formed the impression that a student can pass in the school with very little knowledge of botany.

3563. I judge, from what you stated, that you think a matriculation examination, or an elastic examination of some kind, is a good thing?—Yes.

3564. Would it not be desirable in your opinion that that matriculation examination should be directed to a fair extent towards matters connected with science, because at present nobody seems to contemplate the possibility of examination in anything but literary subjects, and perhaps the elements of mathematics in the matriculation examination?—I have no doubt that the University, if it were to

H. J. S. Smith,  
Esq., M.A.,  
F.R.S.

21 July 1870.



H. J. S. Smith,  
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F.R.S.

21 July 1870.

establish such a matriculation examination, would allow a great number of options, as I said before, and that natural science would be one of them, but I do not think the University would at present consent to require any amount of natural science, however small, from every candidate for matriculation.

3565. That is having regard, I presume, to the present condition of primary education in the country?—It is not only from that consideration, but also from a strong feeling in favour of greater freedom of study which has grown up, and of allowing men, perhaps to an undue extent, to choose for themselves what they will do and what they will leave undone, instead of prescribing precisely what they shall do. All our recent changes have been in that direction.

3566. It would certainly have a prodigious effect, would it not, upon the teaching in the public schools, if the University were to require as much elementary acquaintance with physical science, as they do now require acquaintance with literature at their matriculation?—I think it would be a very great advantage, but it would cause very great opposition on the part, not only of the University, but also on the part of the schools.

3567. You are doubtless aware, that arrangements for teaching elementary physical science are being carried out to a great extent in most of the leading public schools now?—Yes.

3568. Is it probable, therefore, that this objection on their part would cease to exist in the course of a few years?—I have no doubt that in a few years they will be much better prepared to meet it than they would just at this moment.

3569. (*Mr. Samuelson.*) You have spoken of the relation of the colleges to scientific teaching, and you said that they ought to supply tutorial instruction in science; in what manner could they supply tutorial instruction in the experimental sciences?—I will mention one or two things that they might do. One great difficulty in our chemical and physiological departments is, that of teaching the students the elementary physics and mechanics which they require. I confess it seems to me that the course of elementary physics and mechanics ought not to be thrown upon Professor Clifton, or upon any University professor. I feel strongly that a man ought to come to the museum, and to the lectures at the museum, well prepared in subjects of that kind. Again, the elementary mathematics which our students require for the purposes of the professors of the museum, they ought to obtain in the colleges. And even in the case of a more advanced student, take, for example, a stu-

dent in physiology, his education must be, after all, to a great extent, literary. You have to teach him to write about the subjects he is studying, and you have to look over his essays and exercises. You can hardly get that done by a professor; it is work which the college tutors ought either to do themselves, or, if the subjects in question were not in their line, they could make arrangements to have it properly done; they would in that way exercise a very useful supervision over a student, and would ensure his deriving benefit from the lectures that he was attending.

3570. (*Dr. Sharpey.*) In concert with the museum professors at the same time of the student's career?—Exactly so. It would be greatly for the advantage of all parties that the tutorial supervision should continue through the whole of the student's career, and during the whole of his attendance on the professor's lectures.

3571. (*Mr. Samuelson.*) Do you think it would be possible in any way to divide the supervision of book work from the supervision of laboratory work, which latter would be the duty of the demonstrator or the assistant professor, by whichever name he might be called?—I think you could give the college no share in the supervision of laboratory work. They could not undertake any responsibility in connexion with the special laboratory instruction. I think it would be taking them too far from their proper functions, but, at the same time, there is a great deal that they might do which could be separated from that laboratory instruction.

3572. With reference to the first part of your answer, in which I understood you to state that it was a waste of power to expect from the professors elementary teaching in natural science, do not you think it also a waste of the college power to expect such teaching from the tutors there, rather than from those who had charge of the instruction of the young men before they came up to the University?—I do, indeed; but still you must deal with things as at present we find them. A great quantity of work is done at the University of Oxford which ought to have been done long before, and which is simply a waste of the time of those who do it.

3573. But if you are content to deal with things as you find them at present, is there not a great danger that you will continue to find them as they are now?—Some colleges already protect themselves, to a certain extent, by a matriculation examination. But there is no University examination at matriculation, and such an examination would be the only efficient remedy.

The witness withdrew.

Adjourned to to-morrow at 11 o'clock

No. 6, Old Palace Yard, Westminster, Friday, 22d July 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

WILLIAM ALLEN MILLER, Esq., M.D., LL.D.,  
Treas. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

SIR BENJAMIN COLLINS BRODIE, Bart., M.A., F.R.S., examined.

Sir  
B. C. Brodie,  
Bart., M.A.,  
F.R.S.

22 July 1870.

3574. (*Chairman.*) I believe you are Professor of Chemistry in the University of Oxford?—Yes.

3575. Will you explain to the Commission your view of the relations of the University to science?—It appears to me that we have in the greater universities of the country institutions which are available for the purposes of science considered in its

widest sense in two directions: in the first place, as agents for promoting scientific education and diffusing scientific knowledge; and, secondly, that we also have in them agents for a purpose which really has been recognised as one of the objects of these foundations from the most ancient times, namely, for preserving and for extending scientific knowledge. I think that



both those objects should be considered as the objects of a national university.

3576. Do you consider that the second of those objects is sufficiently kept in view at present?—No, I do not.

3577. Are there any difficulties in the way of scientific education at the University?—I think the difficulties in the way of scientific education at the University, as contrasted with literary education, really arise from, what must be called, ignorance. Boys are not brought in contact even with elementary scientific subjects in early life, and, consequently, the great mass of students come up to the Universities, I do not say ill prepared, but not prepared at all in such matters; and the result of this is, that it is difficult for the Universities to construct any definite and available system of teaching at all, for because of this defective earlier education the University itself has to supply the means of the most elementary education, and in many instances to teach those who really have not the very elements of scientific knowledge. On the other hand, a certain number of young men come up to the University who are better trained and who demand education of a considerably higher and more advanced character. Hence there is a real difficulty in organizing scientific education. Another obstacle arises from the inadequate appreciation by the general public of the importance of scientific knowledge for the objects of the various professions to which that knowledge is truly serviceable; and this inadequate appreciation arises, if I may venture to say so, from the imperfect education of the English public in scientific matters. They do not understand the subject sufficiently to be able correctly to judge of its importance and value. Another and yet more important point which they do not appreciate is, the value of scientific education as an instrument for the cultivation of the mind, and for developing the intellectual powers. The result of this want of appreciation is, that large classes who would greatly benefit by a scientific education at the University, simply do not come there at all, and do not even ask for that education.

3578. Do you think it of importance that a definite scientific career should be instituted at the Universities as distinguished from a literary career?—I think it is very important that there should be such a career. The tendency of the various educational bodies is to demand a great deal too much from the student. I mean not too much, if I may say so, in point of depth, but that the student should travel over a great deal too great an extent of ground. I would rather endeavour to concentrate his energies upon important and valuable pursuits, and with this view it would be desirable for the University to offer definite careers of study in all the great branches of human knowledge and thought, and among those branches it should offer a definite career in science. This matter is likely to come very practically before the University of Oxford, as well as before the other Universities of the country. It appears that the Endowed Schools' Commission are about to found certain schools of a high-class character in which the Greek language will not be studied at all; and they have made, through their chairman, Lord Lyttelton, a recommendation to the Universities of Oxford and Cambridge, to the effect that they should no longer insist upon the study of Greek. Not that anyone wishes that the study of Greek should not have its due importance in the Universities, but simply that these bodies should not insist upon the study of Greek as necessary for a degree, and the University now will have to make up its mind whether it will comply with this recommendation of the Endowed Schools' Commission or not. What they say is, that if this study of Greek be insisted on, none of the boys educated in these schools which the Commission are about to found can possibly avail themselves of the advantages of the University; and the same remark may be extended to the whole of the middle classes almost in this country; so that to insist upon the study of Greek is tantamount to

insisting upon the exclusion from the benefits of the University of the great bulk of the middle classes of England.

3579. Do I understand that you agree with the recommendation of the Endowed Schools' Commission, with respect to the study of Greek?—Yes, I do.

3580. Do you consider that the medical and other special scientific schools are necessarily inferior in any respects to those connected with the Universities?—It is impossible for such schools to compete with the Universities. Science, in such institutions, occupies but a secondary position; they cannot have a sufficiently large or varied staff of professors, or, in other respects, adequate appliances; also the student has to commence too many subjects at once, so that he cannot give to science the concentrated attention which it demands, and the result is that, as far as medicine is concerned, the scientific education of medical men is very much even now below what it ought to be. And I think it a very great advantage that scientific education should be pursued in the larger Universities, where there are numerous and competent professors, and where science is studied without immediate reference to practice. With this view I would separate scientific from practical education, and encourage, if not compel, the medical student to lay an adequate foundation of scientific knowledge before entering the wards of the hospital.

3581. Can you suggest any means that would encourage young men who are entering upon the medical profession to resort in greater numbers to the Universities than they do at present?—One way of encouraging them would be, as I have said, by creating a more definite scientific career, and thus giving them what they really require. They would then be able to select from the University instruction that portion of it which was available for their object in life, and to leave the rest. I think it might also be desirable to abbreviate in certain cases the University course, so as to render it not so expensive. These are the two most important recommendations that I would make.

3582. Ought the means of a higher education in your opinion to be in advance of the demand?—That is really essential, the reason being that the general public cannot tell what higher education means until they have it offered to them; they cannot estimate the value of a thing which does not exist, and with which they are not familiar, and I think it is our business to create a system of higher education, and to offer it for their acceptance; if they do not like it, we cannot help it.

3583. The University of Oxford, as distinct from the colleges, has I believe done a good deal lately towards the promotion of scientific education, has it not?—I should imagine that during the last 10 years the University of Oxford, although perhaps the fact may not be generally recognised, has really done more in this respect than any other educational body in this country. Some years ago the great deficiencies of the University came to be recognised, and considerable efforts were made to supply those deficiencies. The University happily was in the possession of funds which enabled it to do what was immediately required, and both in the way of buildings, and, to a certain extent, of professorships and general appliances for scientific subjects, it has done in the most liberal manner what it could.

3584. Does the University possess resources for advancing any further in that direction?—I believe they have pretty well come to the end of their tether.

3585. Are you of opinion that the preservation and increase of knowledge is as generally appreciated by the public as educational objects?—Undoubtedly not. For education we construct an elaborate and costly machinery, and are willing, for this end, to make sacrifices; but, on the other hand, the far more difficult task of extending knowledge is left to the care of individuals, to be accomplished as it may. And yet it is this alone which renders education itself possible.

3586. In your opinion was the case different formerly?—I really am inclined to think that it must

*B. C. Brodie,  
Bart., M.A.,  
F.R.S.*

22 July 1870.



Sir  
B. C. Brodie,  
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F.R.S.  
—  
22 July 1870.

have been so, and that in former days a more real and earnest desire must have existed to preserve knowledge as a valuable national commodity for its own sake than exists now; and the reason that I say this is, that we have existing in the Universities of Oxford and Cambridge records of another condition of things with regard to knowledge than that which exists at present. In the first place, we have extensive libraries which could only have been founded and preserved for the sake of the preservation of knowledge itself; and in the next place the collegiate foundations in the Universities were originally and fundamentally, although not absolutely and entirely, destined for the same objects. This was associated no doubt in the middle ages with a religious object, but still I believe it was fundamentally for the purposes of knowledge that they were founded, and it was intended to have in those colleges societies of individuals associated together for the pursuit and the preservation of knowledge. This object is certainly not less important in modern than in ancient society. I presume that in the middle ages knowledge would altogether have perished if it had not been for such foundations, and it appears that now from other causes the pursuit of knowledge and of general scientific investigation is subject to very real dangers, though of another kind to those which then prevailed, and which make it very desirable for us to preserve any institutions through which the scientific discovery and the investigation of truth may be promoted.

3587. What are the dangers to which you refer?—The dangers to which I refer, are dangers which arise partly even from the growing perception of the practical importance of knowledge, which causes a very great draught indeed to be made upon the scientific intelligence of the country. In the first place, almost every scientific man is caught up instantly for educational purposes, for the object of teaching alone; and in the next place, a very great draught indeed is made upon science for economical purposes; I mean for purposes connected with practical life. In sanitary matters we have numerous examples of the vast amount of work done by scientific men for public and practical objects. So that the supply of scientific men is not equal to the demand for those objects alone. Manufactures offer another great field of scientific employment, and it is to be observed that these are the only ways through which an income can be obtained, the pursuit of scientific truth being an absolutely unremunerative occupation.

3588. Will you be so good as to state to us your views as to the ways in which the Universities may promote the advancement of science?—Considering the advancement of science itself just now as distinct from the advancement of science in the way of education, which is generally recognised as desirable, there are two important ways in which the Universities may promote science of the highest class. In the first place, in a way which is generally recognised as a legitimate mode of action for the Universities, and always has been so recognised, namely, by founding libraries, museums, and collections of various objects of scientific interest and importance. It is really essential for the nation to possess certain storehouses, if we may so call them, of knowledge, in which we may preserve from generation to generation the scientific treasures of the country. We have in London, in the British Museum, a great institution of that kind, but such institutions should also exist in the Universities, not only libraries, but scientific museums and scientific collections, not for educational purposes alone, but for the purposes of pure science.

3589. Do you think that the University of Oxford is not at present sufficiently supplied with libraries, museums, and collections?—I think that the University has the basis of such institutions, but they require extension and development. In the Bodleian library undoubtedly we have one of the most valuable libraries in the world, and in the Radcliffe library we have a most important scientific library; but with regard to museums and collections we are much behindhand, and

the collections, so far as I am able to judge, at Oxford are very limited in their character, and I should say that the object of those collections is purely educational. I do not think that they are, with certain exceptions, kept up or extended with any other view whatever than for the purposes of teaching; and it seems to me desirable, if the means could be found for so doing, to extend those collections, and make them very much more important objects than they at present are.

3590. That would require large additional buildings, I presume?—Certainly it would require additional buildings. I am only saying what appears desirable. However, another and even a far more important way of serving the cause of science in the University would be by providing the means of existence and scientific work for certain professors or individuals, by whatever name they might be called, whose chief function should be scientific investigation and the representation and advancement of their various special sciences.

3591. Should you be disposed to separate teachers absolutely from investigators?—I think that it would be very undesirable to make an absolute separation of that kind. The functions of teachers and of scientific investigators touch one another at many points, and pass almost imperceptibly one into the other. However, although this is true, yet I am strongly of opinion that at the present moment the two functions are very much too intimately mixed up together, and that it would be very desirable to effect a greater separation than now exists. I may illustrate the point by the separation actually made in regard to the other functions of scientific men; thus, for example, we have chemists who are technical chemists, who devote themselves chiefly to purposes connected with the practical applications of their science; but we do not desire to separate those persons off into an absolutely distinct class from the general professors of the subject. Similarly, I should not think it desirable absolutely to separate off chemical investigators from chemical teachers and professors, nevertheless I think it would be desirable to effect a much greater separation of the two functions. If I were asked why a more complete separation of the two functions is desirable, the first reason that I should give is, that these occupations really require very different powers of mind and attainments, and that the two cannot advantageously be pursued to any considerable extent by the same individual; and a distinction of the kind that I suggest really does already exist to a very great extent simply from the necessities of the case. But another very important reason why such a distinction should be made is, that it is very desirable to select for the work which they have to do the persons most competent to do that work, and that to act otherwise involves a great waste of means. Now, it is not true that the most competent teachers are of necessity the most competent investigators. Nor is it at all true that the most competent investigators are the most competent teachers, the powers of mind required being in the two cases very different. Of course there are cases in which those powers are combined, but it is certainly not universally or even generally true. And I have myself seen in appointing to professorships the difficulty which arises in the way of selecting the best man for the office, because, the duties being indefinite, you really do not exactly know who the best person is. The power of organising, teaching, and influencing others being by no means necessarily associated with the highest scientific powers.

3592. To what points would you confine the duties of professors?—I would have different classes of professors, certain professors who should be chosen with reference specially to the educational functions which they would have to fulfil; but other professors too who should be not so much professors of the teaching of the subject as professors of the science itself, and whose business it should be to preserve it and to extend its boundaries.

3593. Would you require them to do anything in



the way of education?—Yes, I should. I should think it very undesirable to create offices in the University absolutely disassociated from educational ends; and indeed I should give to those professors educational duties of the most important character possible, only of a different character to the educational duties of those professors who would be connected fundamentally with the general instruction of the place. In the first place, I certainly should think it desirable that those professors should lecture and give to the public what they have attained for themselves. And in the next place, I should like (speaking of my own department and departments which are cognate with it, and I have no doubt that the same remark would also apply to physiology and to other subjects) to see those professors have under their control laboratories suited for scientific research and investigation, in which they should take a certain limited number of students who would work partly as their pupils and partly as their assistants for those ends. And I should myself say that this is an educational function of the most important character possible, because you would here really carry scientific education to its end. If you do not do this, you stop short at the most important part of all in scientific education. Now the real perfection of science is shown only in scientific inquiry; the perfection of science not only in its general results, but the perfection of science as an instrument for education; and if you leave out in the University system any provision for scientific research, you are leaving out the most important feature of the subject. Those pupils would be persons who would ultimately pursue the science as their main business in life, and become in their turn the teachers and the professors of the subject. I am not giving a mere chimera or dream, but this is already, though not exactly in the way that I am suggesting, carried out to a great extent in Germany.

3594. I understand that you would have two classes of professors, one of them a higher class engaged principally in original investigation?—I do not like at all to call them higher or lower. I am only saying that I should like to see a variety of scientific professorships in the University with various duties and functions attached to them, those various duties and functions corresponding to the different ends and purposes which the science is intended to fulfil.

3595. What in your opinion are the requirements to secure those professors?—Of course the great difficulty is to get the right men, but one way in which you will do this is by offering them what they desire to have. Undoubtedly you must offer, of course, to such a professor, as to others, the means of existence in life, that is essential; you must give him a proper stipend, but above all what I should give him would be the means of doing his work; and speaking from my experience of scientific men, what they really value more than anything else whatever is, the means of doing their work, and for this I should like to see adequate funds provided. I do not think I should go and give the professors for such objects necessarily a certain annual sum; that is not what I mean, but whatever was wanted should be given for those objects. Some persons do not want anybody to help them at all, they work very much better by themselves, others want a large staff of assistants, and others want costly materials and instruments. I should like to see all those things given where they were wanted without any stint, and the best way which occurs to me for carrying out such a scheme would be to have a common scientific fund under the management of curators, to whom application should be made by the professors, and who should consider the propriety of the grant, and assign, after consideration, what was wanted.

3596. Have you at present in the University of Oxford any examples of such foundations as you would desire?—We really have got a capital example of such a thing, namely, the Radcliffe Observatory. Now

the Radcliffe Observatory is an institution founded by an individual of large mind who really appreciated the objects of science. In this institution the Radcliffe observer gives no lectures at all, he is not even attached to the University, he is simply put there to do astronomical work. Then, they have a board of curators, namely, the Radcliffe trustees, who happily also being enlightened persons give to the observer whatever he wants, as far as their means go. I never have heard that any reasonable application for funds was ever refused to the Radcliffe Observer—he has assistants and instruments and a library found for him to the extent of their means, and that Radcliffe Observatory has done a great deal of very good work and constitutes a noble type of a scientific institution.

3597. (*Dr. Miller.*) What is the amount of funds at the disposal of the Radcliffe Observatory?—I do not know, but there are two or three assistants; there is an excellent building, a house for the professor, and instruments, and the like.

3598. How is the board constituted for the administration of it?—The board is the original Radcliffe trustees appointed under Dr. Radcliffe's will; they choose one another, and when a vacancy occurs they fill up that vacancy.

3599. Are they necessarily members of the University?—Not at all, nor is the Radcliffe observer; he is generally incorporated in the University, but he has no duties in the University whatever.

3600. The curators must have large funds at their disposal?—Undoubtedly they must have large funds at their disposal, for not only do they keep up the Radcliffe Observatory, but the Radcliffe Library, which is the great scientific library of Oxford, is entirely kept up out of the funds of the Radcliffe Trustees.

3601. (*Chairman.*) What are your views with regard to the proper mode of appointment of the professors?—To create offices of this kind would be of no use at all unless you could get proper persons appointed to the offices, and no doubt there is a very great difficulty indeed as to discovering the best mode of making scientific appointments. However, I myself have come to the conclusion that by far the best mode of making scientific appointments is to make them by a small board of persons who understand the special subject in reference to which the appointment is to be made, and the sort of board which I would suggest would be this:—In the first place I would put two professors, say, of the subject in the University. I would begin with them, then I would put on the board another official person, another professor, for example, of some other University, to be associated with the two professors that I have mentioned, and would allow those three persons to nominate two other members of the board, individuals to be selected not with reference to a particular professorship, but to be nominated for some time prior to any appointment, men distinguished in science and eminent for their knowledge of the subject of the chair. We have had some experience at Oxford of this mode of constituting a board, and of the way in which it works, and I have come to the conclusion that it is a very good mode of making such appointments.

3602. (*Professor Stokes.*) You would prefer having the elected members of the board elected by the professors, rather than having them elected by convocation generally as permanent members, and not for a particular occasion?—Yes, I would have them elected by the three official members. I do not like appointments by convocation to boards of that kind, which are sure to depend, more or less, upon wrong and irrelevant considerations.

3603. (*Chairman.*) Should you recommend the appointment of a special board for the election of each professor, thereby having as many boards as there are professors?—Speaking generally, yes. It might be possible that the same board might appoint to two or more professorships; but on the principle that I have suggested they must necessarily be special to the subject of the professorships, though not to the individual professor. It would be possible, for example,

Sir  
B. C. Brodie,  
Bart., M.A.,  
F.R.S.  
22 July 1870.



Sir  
B. C. Brodie,  
Bart., M.A.,  
F.R.S.

22 July 1870.

to have one board to appoint to the cognate professorships of chemistry and physics, but I do not think that it would be desirable. I am inclined to have a special board for each subject, if not for each chair. One of the greatest evils that we suffer from at Oxford is from the bad mode of appointment to such offices, which destroys all security that proper appointments will be made. You will quite understand that I am not saying that the results of such modes of appointment are necessarily bad, for that would not be true. In many cases bad modes of appointment have accidentally resulted in good elections; but still the modes of appointment are, as a rule, fundamentally bad, and the late commission, which created several new professorships, devised pretty well as bad modes of appointment as those which existed previously. In some cases the commission placed certain official members on the board which appointed to the chair who might be supposed to have a knowledge of the subject; but then they took good care to neutralise those members of the board by others who could not be expected to have any knowledge of the subject at all, or interest in connexion with it; and one of the most important things that this Commission can give itself to is, to the consideration of the proper mode of making scientific appointments, without which all other changes must result in disappointment.

3604. (*Dr. Miller.*) Do you think that it does not sometimes neutralise any feeling of cliquism which may be possible by introducing someone from without who has no special connexion with the subject?—I think that introducing someone from without may be a very good thing, but not anybody from without, and I do not think it can be beneficial to introduce somebody who knows nothing whatever about the matter. What is the judgment of such a person worth?

3605. Not as a sort of moderator?—Not at all. He may vote, but his opinion can carry no weight. The late commission, for example, put upon certain boards such individuals as these the visitors of the college, who might be the Archbishop of Canterbury or the Bishop of Winchester, or some other ecclesiastical dignitary, the president of the college, perhaps the Chancellor of the University, and so on; but the visitor and the president or head of the college would most probably have no knowledge at all in the matter; they would have no means of judging of the qualification of the candidate. I am very much for trying to neutralise and get rid of the evil which you mentioned, namely any kind of cliquism, but I would do it in the way that I suggest, namely, by introducing individuals on the board not connected with the University, but connected with the science, and whose opinion would have a real and not simply a false and fictitious value. Let me say why I lay such great stress upon being connected with the science. The reason is this: first, that they alone understand what is wanted, and, in the next place, that they are the only persons who, in such a matter, are truly amenable to public opinion. We might think that great officers of state, such as appear on some of our boards, were amenable to public opinion; but it is not so at all, because really the only public opinion which is available is scientific opinion, the opinion of scientific men, who are responsible and amenable one to another, as regards such duties, in a way other persons are not. In their eyes such matters are important, they will take pains about them, and are very unlikely to go wrong.

3606. (*Chairman.*) Do you think that the occasional appointment of eminent foreigners to professorships would be attended with advantage?—I should like to see the thing left quite open, and to take the best person that could possibly be procured. Of course it would be for the board to consider who was suitable or not suitable, but in my opinion it would be very desirable, occasionally, to appoint to professorships in the Universities in England eminent foreigners. In certain cases when this has been done the result has been eminently beneficial. The Universities should not be local or even national institutions, but agents

in the great European movement for the extension of knowledge.

3607. Do you think it would be indispensable in those cases that such a professor should be well acquainted with the English language?—I really think I should leave the board to settle all those questions. You can hardly lay down very absolute rules. Of course familiarity with the English language would generally be necessary, but sometimes other considerations would preponderate. I would lay down no such rules.

3608. Can you point out to us any sources from which the funds for the objects of which you have been speaking could be derived?—This of course is the great difficulty, and it would be no use to make such suggestions at all as I have done, unless there were the means for carrying them out. I believe, however, that such means absolutely exist, and indeed I have a very strong conviction that before long they will be turned to this or other cognate objects. Those means are the endowments of the colleges of Oxford and Cambridge. These endowments have been from time to time dealt with by Parliament, and the time has now, in my opinion, come for dealing with them again. They have been partially dealt with by the late University Commissioners, who changed the destination of many of those endowments, and a very strong feeling is growing up in the University of Oxford for further analogous changes. This arises from a sense of inutility as regards the objects and ends for which the endowments are at present held. Formerly the greater number of the fellowships in the University of Oxford were limited, in some mode or another, to counties, schools, or the like, and nearly all were given away without any immediate or necessary reference to merit at all. That system existed not many years ago. The great benefit which was conferred upon the University of Oxford by the late commission was undoubtedly in compelling the colleges to recognise attainments and intellectual merit in the awarding of fellowships, and not only to recognise these, but to award their fellowships after examination and at Oxford, at any rate, the colleges have, I believe, very honestly carried out this part of the obligation which was laid upon them; but the result has been to create or perpetuate a great number now, and what in a few years will be a far larger number still, of fellowships to which considerable stipends are attached, but with no corresponding duties. It is not true that the fellowships to any great extent promote education even in Oxford itself, for notwithstanding all their fellowships several of the colleges are absolutely in want of tutors to carry on the instruction of the place, so that the fellowships do not even fulfil that end. Fellowships were never intended by their founders to be given away as prizes after examination, or as prizes in any way, but to serve the purpose of real study, and for the benefit of real students, and I confess that I should like to see the great bulk of the fellowships restored to their original purpose in this respect, namely, for the promotion of knowledge and the benefit of real students. The late commission taught us how to do this, for in certain of the colleges they suppressed and consolidated the fellowships, and constituted professorships out of them. The professorship that I myself hold was founded out of an aggregation of certain fellowships in Magdalen College. The Professor of Physiology has a fellowship similarly consolidated out of the revenues of Merton College; and this method of dealing with the revenues of the colleges might advantageously be carried a great deal further, so as to devote these vast funds to really important objects. The college revenues are enormous, so that there would be no lack whatever of means. It is difficult to get precise information on this subject, but it is said that after the lapse of a few years there will be as many as 300 fellowships in the University of Oxford, ranging in value from 200*l.* to 300*l.* a year; that is to say, there will be an annual fund devoted to fellowships alone of certainly not less than 75,000*l.* a year, and this after all



the buildings of Oxford are kept up, and other necessary expenses of the colleges paid. Then besides these are the numerous headships of colleges, which are part of the same fund, and which must be considered together with the fellowships. The annual value of the headships is probably not less than 20,000*l.* Therefore, you cannot put the whole thing at less, say, ultimately than 100,000*l.* a year. These funds are now disposed of simply in the way that I mention, that is to say, the fellowships are simply prizes given away after examination, and for which no service whatever is rendered to the community. To the headships of colleges only the very slightest duties are attached. The system of fellowships is simply a system of sinecures, given, if you will, to meritorious persons, but still sinecures. It is impossible that such a system can last.

3609. Would you still be disposed to reserve a certain number of fellowships as prizes?—Yes; I think it would be reasonable to do so in the case of a certain number, for I think this would stimulate education in a beneficial but not excessive way.

3610. (*Dr. Miller.*) Why do you say that the colleges will have these funds after a certain lapse of time?—In many cases the colleges are under obligation to found scholarships, and here and there a professorship, which causes just now a drain upon their funds. Also their property is increasing rapidly in value by running out leases, which involves some sacrifice of present income, and in other ways.

3611. (*Chairman.*) The colleges are not spending the whole income in their annual expenses?—No, even now some colleges have, I believe, an income beyond what they are permitted to expend in fellowships.

3612. The greater number of fellowships are given, are they not, for proficiency in the older studies?—By far the greater part of them, and the result of that is, that they bolster up those studies, and act as a system of protection towards them, which prevents them assuming their proper position.

3613. (*Dr. Miller.*) Do you approve of the system of a matriculation examination for students entering at Oxford?—I am inclined to think it is good to have a matriculation examination.

3614. Would you give a considerable option, or would there be a definite course of study required?—I think considerable option should be given, so that all forms of education should be recognised, and only the idle and incompetent excluded.

3615. Do you consider that the tutorial system is one which, on the whole, is good in its results at Oxford with reference to science?—It is very little exercised indeed with reference to science. There is very little tuition given by the colleges in scientific matters, but I believe that such tuition as is given is beneficial.

3616. Do you see your way to anything like intercollegiate tutorial instruction for scientific purposes?—The colleges are really from the necessities of the case reverting to the system of professors, in the so-called intercollegiate system, which is nothing but an imperfect professorial system.

3617. In fact it is almost the only way in which you could meet the necessities of the case, is it not, because the colleges would hardly be able otherwise to find instructors?—I believe that is one difficulty. Another thing is, that much better instruction is given in this way, because the tutor is able to limit his instruction to a subject which he has studied and understands, which is not the case in the tutorial system, where one tutor gives instruction in a great variety of subjects.

3618. Do you see any difficulty in providing assistants or demonstrators out of the college funds in aid of the present professorships for experimental science?—Not the least difficulty, if they like to give the money.

3619. What is your opinion as to the arrangements which would be likely to be made under the present system?—I think there is a general opinion in Oxford

that something must be done by the colleges to assist the University, but of course the difficulty here is that some colleges are willing and some are not.

3620. You do not see any difficulty in the museum, for example, working in harmony with the tutors of the colleges?—None at all, for the two are independent, and do not come into collision; but then there is, as I say, very little collegiate instruction in those subjects, and, as a matter of fact, nearly the whole of the scientific instruction is in the hands of the professors.

3621. Have you adequate assistance at present?—Yes, I have found me by the University a sufficient staff for the subjects now taught.

3622. Leaving yourself leisure for such investigations as you would desire to make?—Yes, a certain amount of leisure, but I have during the term very little time for private work.

3623. Do you consider that in the University the professors ought to be engaged in delivering elementary lectures?—I should certainly think in one sense no, in another sense, yes. We may all say that elementary instruction in the principles of his science is an essential part of his work. It is very important to have those elements, as they are called, properly treated, but of course if it be meant that the professors should give the most rudimentary instruction in the subject, and enter into minute details of elementary science, certainly not. I think that ought to be done by others.

3624. (*Professor Stokes.*) You spoke of two classes of professors which you called for distinction's sake teaching professors and investigating professors, although the two functions are not to be wholly separated; would you advocate the establishment of a definite number of chairs of each kind?—I should consider what the requirements of the University were in the way of teaching, and then I should take care that those requirements were properly met, and whatever number of professors were required for that subject should be appointed, with whatever apparatus and laboratories should be required; and I should also establish other professorships, not, as I before said, entirely distinct from teaching, but nevertheless special professorships.

3625. The object of my question was to elicit your opinion as to whether it would be desirable to create definite chairs to be filled by people that you called investigating professors, or whether you think it desirable that there should be funds free to create such professorships according as you found men to fill them?—If they were not created as permanent institutions there would be no guarantee that they would be filled up, but I do not think it should be obligatory on the board to fill up a professorship if there were no competent person to hold it. I think also that there should be means of founding special professorships of the kind that I have suggested for individuals, for the University ought never to lose any power of that kind which it can possibly attract to itself, and it is for the benefit of the nation to utilize all the power of that kind which exists in it. I think there should be special professorships, but I think also there should be the power of creating such chairs for individuals willing to devote themselves to scientific investigation.

3626. (*Sir J. Kay-Shuttleworth.*) Did I rightly understand you to say that the teaching and investigating power of the University should be considerably in advance of the demand?—Yes, I think so.

3627. You would anticipate, would you not, that by the operation of the Endowed Schools' Commission in the introduction of scientific instruction into those schools, provided there were due encouragement offered in the University, the number of students presenting themselves for scientific instruction in the University would probably be greatly increased?—Yes, the great defect is the want of early education, and if this were remedied the number of cultivators of science would be largely increased.

3628. And I gather from your evidence that, as an encouragement to the increase of the number

Sir  
B. C. Brodie,  
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F.R.S.

22 July 1870.



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of such pupils, you would wish a very considerable diversion of the funds of the colleges towards the objects of scientific instruction?—I think it desirable that the teaching power of the University should be in advance of the duties which it has actually, at a given moment, to fulfil. It should never be said that the University could not teach those who come to it to be taught, but I do not think it would be desirable to create a number of empty laboratories, in hopes that students would some day occupy them. I would act with moderation, and meet such demands as they arose, but I would always meet them.

3629. The intention of my question was to look forward to the time when the number of students of science in the University had, by the means to which I advert, greatly increased, and there was a demand for greater teaching power in the University?—I think provision should be made for the future, and that demand should be met mainly from the collegiate revenues.

3630. As respects the existing professorships of science, do you conceive that professors might be greatly relieved by the appointment of demonstrators and assistants to their respective chairs, so that they might have a larger amount of time at their disposal for scientific research?—I think it desirable to relieve them far more than at present. I do not think, however, that the tendency of the University itself is at all to overpower the professors at the present moment with educational work, but nevertheless the necessities of the case may do that, because a professor does not strictly limit himself to the obligations imposed upon him. He is zealous for his science, and he feels it incumbent upon him to do whatever he can for the benefit of the science which he represents, and many professors go through a very great amount of work indeed beyond what is absolutely incumbent upon them. The pressure is not less real because it is not absolute compulsion.

3631. What I wished to approach was this question, whether you would consider that it would be desirable that the scientific instruction of the University should be chiefly given in a central school, like that which surrounds the museum, or to what extent it should be collegiate, or whether the two modes of instruction could be made harmonious?—Special collegiate instruction in science is not likely, in my opinion, to come to much, for really it is not worth while for a college for the sake of a few students to erect buildings, and to get apparatus, and to pay properly the persons who are to teach; and unless some great change is made in the collegiate system, I do not think that mere separate collegiate instruction is likely to come to much. Such instruction may be a useful supplement to other instruction and may help to keep the students a little together, and I have no doubt they benefit occasionally by the lectures that are given them, but it is at the present moment very limited in amount and strictly supplemental to the other.

3632. Supposing there were 10 times as many scientific students in the University as there are at present, and it were desirable that the instruction in science should continue to be as it is now, chiefly of a central and not of a collegiate character, the diversion of the funds of the colleges to such scientific instruction would probably therefore be in relation to that central institution?—It is difficult to pronounce about the future, and necessities which are non-existent altogether. It might be beneficial to have two or three centres in Oxford; at the same time, I am of opinion that at the present moment it is best to centralise the instruction, because we have a very good centre for it, and there would be a great waste of means in doing otherwise.

3633. You are unwilling to anticipate at this present moment what extent of subsidiary instruction might be collegiate, and what extent of general instruction might be central, or how the two might be made to harmonise?—Yes, I should like to know exactly what is required before I give an opinion

about it: at the same time I am distinctly in favour of centralization.

3634. (*Professor Huxley.*) In a letter addressed by Lord Lyttelton to the Vice-chancellor of the University of Oxford, to which you have referred, there are these two paragraphs: "We are convinced that in order to give fair trial and full play to the study of modern languages and natural science, it is necessary to establish some schools of the first grade (*i.e.* schools retaining their scholars to the age of 18 or 19), in which these subjects should be the staple of the course of study, and to that end the time and importance assigned to classics be much diminished." And then again, in the 11th paragraph, it says, "No school can be other than a classical school in which Greek is effectively studied." The obvious tendency of those opinions is to the belief that classical and scientific instruction of a thorough kind cannot possibly be given in the same school; is that your opinion?—I cannot imagine that to be impossible, but special arrangements would be required to secure its being done.

3635. The opinion of the Commissioners, expressed by Lord Lyttelton, is evidently expressed in another paragraph, "Nor can the ancient and modern studies be wisely put as rival objects of pursuit in the same school, with the almost inevitable result of the supremacy of the one and the decay of the other." For, as experience has shown, the one to decay is that which has not got on its side long usage or established reputation, or the associations of old institutions, or the sympathies of the great body of teachers, or the substantial attractions of endowments." Without expressing any opinion as to what may be the state of affairs now, is it not imaginable that if the Universities gave the same rewards for the study of science as they do now for the study of classics, those two lines of education could go on in the same public school?—I should think so; indeed I do not myself appreciate why it should not be practicable; but that is different from saying that the same individual boys should be taken and taught everything, which, I think, impracticable.

3636. The argument of the Endowed Schools' Commissioners all tends to the setting up of what may be called science schools or modern schools, totally apart from the classical schools; do you agree with that?—It might be a good thing to do that in special cases, that is to say, to have a few schools of that kind, but I should think it a bad thing to be done universally.

3637. Do you think it is desirable to separate the literary from the scientific training for the general education of the country?—No, I do not in early life, undoubtedly. I think it better that they should go on together. Science is benefited by literary culture, as well as literary culture by science.

3638. Do not you think it desirable that a certain amount of scientific training should form part of all primary education whatever?—Yes. No man should be considered educated who is destitute of the fundamental conceptions of science. The result of such a separation would be to leave a large portion of the community no better off than at present, which is eminently undesirable.

3639. There should be therefore no difficulty in giving a certain amount of sound elementary training in science to schoolboys between 12 and 17?—I should think not. I do not see why that should not be done, and then that a branching off should take place, into different lines of study for boys to a limited extent, as is done for men afterwards to a greater extent.

3640. Surely it would be the most undesirable thing in the world that one half of the population of this country should be accomplished men of letters with no tincture of science, and the other half should be men of science with no tincture of letters?—Certainly.

3641. Does not that appear to be the tendency of this letter?—Yes, so far as you have explained it to me, but I have not myself fully considered the suggestions of the Commissioners, and should like to have them



fully before me before pronouncing an opinion upon them.

3642. You have spoken of the impediments to the pursuit of science. May I ask if it has not suggested itself to you that one arises from what I may call natural causes, through the great wealth of the country, that is to say, the temptations to men of ability to go into mercantile pursuits are so great that many of the best heads of the country are simply dragged off in that direction, whether they go to the Universities or not? Suppose, for example, a man distinguished at the University, if he takes to a scientific career I need not tell you what are his temporal prospects?—We know them very well.

3643. If he takes to law or to physic or to commerce the chances are that if he is a man of any ability and energy at all he will be making his 3,000*l.*, 4,000*l.*, or 8,000*l.*, or 10,000*l.* a year?—Clearly.

3644. You and I know a score of cases where men of no exceptional abilities starting as we have done ourselves, but having taken to manufacturing or commercial pursuits, are making exceedingly large incomes?—Yes.

3645. Is not that one of the greatest impediments to science in this country, and greater than any artificial impediment?—No doubt it is a very great impediment indeed, but even that impediment would to some extent be remedied by a more general appreciation of the importance of science, because scientific men would be much better remunerated if the nature of the services that they render to society were more generally understood.

3646. But suppose you and I had two sons of equal ability, and we put one of them into a scientific career, and the other into physics, or law, or commerce; the scientific man, whatever his distinction, could not by possibility hope to make a fifth part of the income of the other?—The causes which you mention, are, I quite admit, really operative in deterring capable men from giving themselves to a scientific career. But, nevertheless, science demands special aptitude, and it is by no means certain that the most eminent scientific men would succeed in active professions. Also, pecuniary recompense is no adequate measure of the comparative attractions of the various employments of life, and what you say of science is true, to a great extent, of the more learned professions also. From a pecuniary point of view, it is far better to be a successful contractor, or maker of steel pens, than Lord Chancellor.

3647. I presume you would not contemplate raising the rewards of science in a money point of view to rectify that?—No, certainly not; we cannot pretend to modify to such an extent the conditions of society, but I think there should be the means of reasonable existence for scientific men. I do not now wish to go beyond that, but I do not think that that is given at present. The standard is pitched altogether too low, but I certainly think that upon the score of money you cannot make scientific occupations compete with other occupations. They have their own advantages of a different kind, but still you should give to those who devote themselves to scientific pursuits reasonable means of existence.

3648. My questions were directed to the purpose of showing that, quite apart from all the artificial obstructions that we know exist, the great wealth of the country creates, as it were, what I may call natural obstructions to the pursuit of science, so that the deadness of the public mind to science which you speak of does not wholly arise from those artificial difficulties that are put in the way of science, but must exist as long as the country is as wealthy as it is?—Yes; but there are many operations in which the intervention of science is desirable where science is not called upon to intervene, and the reason of that is the inadequate appreciation of science by the general public.

3649. When you speak of increasing the collections at Oxford, do you think it would be desirable to increase the collections there beyond what may be

needed for educational purposes?—I think that the collections should be adequate to the scientific wants of the University, whatever those wants may be.

3650. Supposing that unlimited funds existed, do you think it would be desirable to make your physiological collection in any sense a rival to the College of Surgeons' collection, or your collection of natural history subjects a rival to the British Museum?—That depends, perhaps, upon what objects would be served by such a collection, and whether more than one such collection in the country is really needed at all. I feel myself not competent to give an opinion upon that point, but I do not think it desirable so to limit those collections that there should be no means of prosecuting the higher studies by means of them, or that educational objects should be exclusively regarded in their formation.

3651. You spoke with considerable praise of the Radcliffe fund, and the way in which it is managed in the promotion of science; but I did not gather what evidence of work has resulted from the Radcliffe observer?—He makes an annual report on the condition of the observatory and the work done.

3652. Does the observer publish tables of the stars?—Yes, but other persons know more than I do about that. There is an annual meteorological report, for example.

3653. There is tangible evidence of work done?—Yes, certainly.

3654. Is it not the case that, besides the teaching of chemistry by the professor of chemistry in the University of Oxford, the same teaching goes on at certain of the colleges?—Yes, in several cases. At Merton there is a lecturer on the subject. At Christ Church, too, they have recently instituted a laboratory.

3655. Is that laboratory built at the expense of the college?—They are fortunate enough to have a fund founded by Dr. Lee, and it has been done out of the Lee's fund.

3656. Is the laboratory there upon any considerable scale?—No, upon a small scale.

3657. Is it for the teaching of the students of Christ Church exclusively?—Yes. I believe others go to the lectures, but not to the laboratory.

3658. Are the lectures open to the members of other colleges?—Yes, I think so.

3659. You were speaking of the desirableness of professors being appointed for special branches of science, somewhat, I fancy, upon the footing of the extraordinary professors in the German universities. That was the model, I presume, of which you were thinking?—When I said special branches, I really meant for individual sciences, and for the parts into which the individual sciences break up. I did not mean professors of details.

3660. Do not you think that the mechanism of fellowships might be turned to account in that direction; that is to say, supposing you had an able man, who devoted himself to some special branch of science, could not you give him a fellowship, and let him hold it as long as he was showing evidence of work in that direction; might not that be a manner in which a fellowship could be converted into what would be practically an extraordinary professorship?—I have already suggested a mode of thus utilising these foundations. Of course, whether you call a thing a fellowship, or whether you call a thing a professorship, does not very much matter. But if you mean to ask whether I think that the existing mechanism of fellowships can advantageously and conveniently be thus utilised, I think not.

3661. So that you have, in fact, funds ready to hand?—Yes; but there is not the means at the present moment of thus dealing with those funds, and there is not the body to deal with them, nor can they be thus dealt with without the intervention of Parliament.

3662. Supposing for a moment it were decided that you could dispose of the funds of the colleges as you pleased, that would be the method in which you would utilise many of the fellowships?—Yes, I cer-

Sir  
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22 July 1870.



Sir  
H. C. Brodie,  
Bart., M.A.,  
F.R.S.

22 July 1870.

tainly should; I should consider knowledge as a whole, and proceed to do the best with the fellowships which I could in the interests of knowledge.

3663. But few methods could be devised better than that of giving men with the power of investigating in a certain direction the means of doing it?—I think that that is something like what I said I approved of in reply to Professor Stokes. What I wish to see effected is, a redistribution of the collegiate endowments in a sense more favourable to utility and to the progress of science and knowledge. But it is futile to attempt to do this with the present arrangements. The system must be melted up and recast.

3664. Do you think that any movement in that direction is likely to take place from within the colleges?—I think that some would be in favour of it, undoubtedly, and others not, and some colleges would be more in favour of it than others. But I do not think it probable that the colleges, as a body, will move in the matter.

3665. Of course in this country there is a very great prepossession in allowing changes to be made spontaneously and gradually by the action of the persons concerned themselves, and I imagine that if there were much hope of the colleges themselves taking the initiative, there would be very little disposition to put any pressure upon them from outside?—Such expectations are quite unreasonable and without any foundation, but I think that what you might hope for would be that when you did put the pressure from outside there would be considerable sympathy from within. But if you mean to say that the colleges should spontaneously devise a plan of this kind, and combine together to do it, I think that that is more than you can really hope for, for the difficulties in the way of doing it are too great, but you must not think that for that reason there would be no sympathy with such a proposal.

3666. Are the elements of decomposition present which might be taken advantage of?—Yes, for the present system works very badly in the interests of education; moreover, such changes must necessarily be very gradual indeed, because nobody would propose to go and recast at once such an institution as fellowships. Vested interests would have to be respected, to begin with, and those vested interests will take a very long time to die out, and it would be years before you could really hope for the revenues of the colleges to come very largely to your aid; you must proceed very gradually, but I think that something of real importance might be done *instantly*.

3667. That is the direction in which as I understand you think changes might take place?—Yes, I do. It is rather curious to note the vicissitudes of opinion upon these subjects. I believe originally that the colleges were not educational bodies at all, that they were simply associations for the purpose of learning and religion. There is one college at Oxford which has stoutly resisted ever being turned into an educational body, and which has got no students at all, unless it is a Bible clerk or two, and that is All Souls' College. Of course I do not approve exactly of the institution of All Souls' as it exists, but nevertheless some feeling is really growing up that it is rather a benefit to have All Souls' than not, because it shows the type of another kind of college than a purely educational foundation.

3668. Do not you think that human nature being what it is, it is rather a dangerous experiment to allow men to enjoy the means without being required to show anything in the shape of work for them?—The experiment has been tried at Oxford on a large scale, and you know the results.

3669. (*Dr. Sharpey.*) Supposing that the colleges were disposed to allow a redistribution of their funds in that advantageous manner which you suggest, would they have the power to do so?—No, they would have to surmount all sorts of obstacles, and to move heaven and earth before they could do it.

3670. Even though they were willing?—Yes; but

in the first place they would not be willing, and, in the next place, if they were willing, they certainly would not have the power.

3671. This power would require to be obtained from Parliament?—Yes, it would have to be obtained from the Legislature, and this is what I wish to impress upon the Commissioners.

3672. If I understand you rightly, you prefer that a portion of the collegiate funds should be placed at the disposal of a board of curators to apply them to the general purposes of science in the University?—So far as I have ventured to form any definite scheme of the kind, I think that there are two ways in which the thing might be done, and both of them simultaneously; first, by contributions, from the various colleges, to a common fund for educational objects and scientific objects.

3673. How would that be procured?—It might be made by assessing a rate on the revenues of the colleges.

3674. At whose disposal would it be placed?—At the disposal of a board of curators appointed by the University; and the other mode is by the foundation within the colleges themselves of university professorships connected more or less with the colleges. It is not necessary for that to destroy the fellowships, but gradually to transform them into professorships.

3675. Those professorships might be for systematic instruction in science, and they might be devoted to the special branches which the holders of such professorships might have advanced?—Yes; I do not wish to relieve the professors from any real obligations. There must be considerable power given to the University in such matters. Also, professorships might advantageously be associated with the headships of colleges, precisely as now with canonries at Christ Church. The head of a college has very limited duties to perform, his is almost an honorary office, and I should have thought that those offices might most reasonably have been held by learned and scientific persons.

3676. (*Mr. Samuelson.*) Did I rightly understand you to say that public opinion in the University of Oxford was rather tending in favour of the extension of scientific studies?—It certainly is much more so than in former times. There is more appreciation of scientific studies than there used to be.

3677. And that appreciation is still increasing?—Yes, I think so, to some extent.

3678. You stated that there were obstacles in the way of the colleges of their own mere motion doing all that it might be desirable to do for scientific instruction?—There are many real obstacles in the way of their action; but I cannot say that they do all that they have power to do. With regard to the distribution of fellowships at the present moment, it is very rarely that fellowships are given for scientific eminence. They are now and then, but not often; and yet the colleges are absolutely bound by their statutes to recognise these studies among others.

3679. Would there be anything in the statutes of the colleges, as far as you are acquainted with them, which would prevent the colleges from attaching professorial duties to certain fellowships, or making residence a condition of them?—I should not like to answer that question without further information. I am inclined to think that they could not do so with regard to the fellowships which exist, and, moreover, they could not relieve the fellows from the obligation of celibacy. A fellowship terminates upon marriage, when it falls to the ground *ipso facto*. They have got a great many changes to make before any real use can be made of fellowships.

3680. (*Professor Huxley.*) Cannot many colleges elect to fellowships after marriage?—The late University Commission allowed them to elect any professor to a fellowship, which has been acted upon in two or three cases, but they have no further power.

3681. (*Mr. Samuelson.*) Still upon the whole you are decidedly of opinion that without legislation no



comprehensive scheme could be carried out?—Yes, I am of that opinion.

3682. Do you think that public opinion within the University has advanced so far as to desire legislative interference?—It is difficult to say what public opinion is within the University, but there is no doubt a certain body of opinion in favour of legislative interference.

3683. Is the number of persons who desire a change of that character becoming larger in the University?—If you ask me my private opinion I think it is. A book has been written by the Rector of Lincoln College in relation to the collegiate endowments, advocating something of the sort of thing that I have suggested, and there are other indications of a movement in the same direction.

3684. Are not those views now looked upon as less startling than they were when that book was first published?—Yes, I think so certainly. I really think that there is a great tendency in favour of certain changes; one is in favour of having more professors of a subject apart from merely teaching professors. In the next place, I think that there is a body of opinion in favour of devoting collegiate endowments to more useful and beneficial purposes than those to which they are now turned.

3685. How far has the subject which you profess been affected by the change in the statutes which permits the presence at Oxford of unattached students?—I should think hardly at all; not at all that I know of.

3686. Have you any acquaintance with the extent generally to which that statute has been availed of by students?—It is coming into considerable play, quite as much as could possibly be expected. I think that there are now as many as 73 unattached students, and they amount already to the number of a considerable college; but as far as my science is concerned, there is, as far as I know, but one student in the laboratory of this class.

3687. Seeing that your science is one in which, perhaps, there is as great a demand for teachers, and

The witness withdrew.

GEORGE ROLLESTON, Esq., M.D., F.R.S., further examined.

3691. (*Professor Huxley*.) When you were before the Commission on the previous occasion, you spoke of the principle of bifurcation, and that boys who have a special faculty for learning science should have an opportunity of being taught while they were still boys, but do not you think that all boys possess the faculty of receiving instruction in science to a certain extent?—Yes, I think so; but by bifurcation, I meant that when a boy had a very eminent call, or showed particular capabilities for science, he should be allowed to concentrate himself upon it. But just as I would oblige him to have a certain minimum, and that minimum of literature culture as high a one as is possible, so I would oblige a person with literary capabilities to go through a certain minimum of physical instruction.

3692. So that in fact, as I apprehend, you would have in every school an education both in the scientific and the literary branches as a foundation for all education whatever?—Up to a certain point, and then I would let the bifurcation come in, and that point would be measured by years, perhaps say the age of 16.

3693. It is not uncommonly stated that particular boys are devoid of the faculty of understanding scientific reasoning, while others are devoid of the faculty of comprehending literary beauty; but do you think it advisable to legislate for a nation of idiots?—I think that such cases are very few in number, and *de minimis non curat lex*. There may be such, but I have not met with them.

3694. There is a letter, with which you are doubtless acquainted, addressed by Lord Lyttelton, and the whole tenor of that letter leads to the conclusion that the Endowed Schools' Commissioners are of opinion

which also has as direct an application to the great industries of the country, as any other, how do you account for the paucity of unattached students in your particular case?—I do not know with what object the unattached students come to the University, or from what classes of society they come. All that would have to be considered in answering such a question. Also the system has been in operation for too short a time. So that these students are in too early a period of their university career to have entered on the study of a special subject. Out of these 73 students only 12 have, as I have ascertained, passed their moderations, and it is quite exceptional for a student to enter the laboratory before that period. Considering the diversion of interest which is made by the fellowships and the scholarships in favour of other studies, the physical sciences, chemistry included, so far from not being followed by few students at Oxford, have really made far greater progress than could possibly have been anticipated.

3688. Having regard to the number of prizes held out by the University?—Yes, from being a mere shadow they have become a most substantial reality, and occupy an important position in the University system.

3689. Referring to what was said about the great temptation afforded by professional and mercantile and manufacturing pursuits to divert students from the pursuit of pure science, is it not also the case that the growing wealth of the community has created large additions to the leisure class, who might be expected to overlook pecuniary considerations if the appreciation of science were greater?—I have no doubt that that would be so. If science were better understood, and if they were better educated in the subject in earlier life, many of those who have leisure would pursue the study of the physical sciences.

3690. Just as now many enter the church and many go to the bar without any hope of ever realising any great income from either of those two sources?—Yes. They would pursue science as an important and interesting occupation, just as many of the same class follow a political life.

that classical studies and scientific studies cannot go on in the same school, and that you must even at the early stage of education have separate schools; one with its tendencies mainly classical, and the other with its tendencies mainly so-called modern and scientific; do you think it is a good thing to separate the education at that early period?—I am sorry that I should have pledged myself rather to the reverse of that. The Commissioners no doubt are right, and I must be supposed to be less likely to be right; but I certainly do not think it a good thing to start those higher schools of science apart from classics. I am strongly of opinion that it is a great point in education to keep all classes together as much as you possibly can. I read the letter of Lord Lyttelton with reference I think to the founding of a school in the north of England, where that experiment is to be tried, and I think it is of great value that the experiment should be tried, but I am strongly of opinion that the other plan is better; that if you can get a fair amount of freedom conceded to the scientific instruction it is better not to separate the science from the literary culture. I do not know that my opinion is worth very much upon that point, but certainly that is my opinion.

3695. You yourself have gone very fully both into the classical and into the scientific studies of the University of Oxford, and therefore few persons could be better able to form a judgment; do not you think that the most unfortunate kind of human being in existence is a literary man who knows nothing else but literature, and that the next most unfortunate is a scientific man who knows nothing else but science?—I certainly am distinctly of that opinion. The great point is to see that everybody should have a tincture of both, and

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I think that one wise means towards that is by increasing science as an element equipollent and with equal reputation in all schools alike. The letter of Lord Lyttelton, which was published in the Oxford University Gazette, in which we put all our official notices every week, I think gives a little too much weight to "the sympathies of the great body of the teachers," and to such facts as those of the head masters of public schools being sometimes a little in the habit of disparaging the value of scientific education as compared with that of classics. Dr. Moberly I think may be taken as the person who has pronounced himself in that sense most strongly against the system of bifurcation. (See Nine Schools' Commission Report, i. pp. 146, 147, *ibique citata*). But if a master gives fair play in a school to both subjects, I do not see that public opinion would not shortly be fair also. But of course an elder person has great power of setting the tone of a place, and if a man who is at the head of an establishment depreciates any particular line of study young persons are quite sure to do the same. Young persons are much more guided by that sort of way of speaking than older persons are.

3696. Is it within your knowledge that any existing head master of any great public school at present has had any scientific training, an acquaintance with science?—It is not within my personal knowledge. I have heard that the present head master of Rugby has done what he could on behalf of science teaching, but I have only heard that, it is not within my own knowledge.

3697. Are you aware of the teaching in science that was given by Mr. Wilson and other masters in Rugby long before the advent of the present head master?—Yes; in Dr. Temple's evidence, which was given to the Public School Commissioners (*l. c.*, vol. ii. p. 312, and vol. iv. p. 270), you will find that Dr. Temple certainly spoke in very much the same spirit as that in which Dr. Moberly had spoken in his utterances, although I think in a somewhat more measured form. Then, since the Commissioners introduced certain regulations whereby natural science was to be introduced into the Rugby curriculum, those instructions have been loyally and honestly carried out in Rugby. And about three years after that, you had Mr. Wilson's evidence in the British Association (Dundee) Report to the effect that the tone of the school had been improved, and that the classical studies had not at all fallen into the background, and that the course of natural science was so much clear gain. It is, I think, of consequence to note that Mr. Wilson says that, as he is a person evidently in intimate relation with Dr. Temple. For in the little geometry book by Mr. Wilson, a second edition of which has recently come out, you will observe that he says that Dr. Temple had given him a number of suggestions as to recasting this elementary work on geometry. And being on such terms with Dr. Temple, it is significant that with reference to the science teaching he says that he believes every master in Rugby will confirm what he says. You will find that in the report on the teaching of natural science in schools which was presented to the Dundee meeting of the British Association in 1867, the Public School Commissioners having reported in 1864; so that three years had been given for the experiment.

3698. Are you of opinion that a head master, whose sympathies and whose intelligence were equally directed towards science and literature, might cause the two lines of study to be carried on on an equal footing in a public school?—Yes; I think it merely requires an adequate knowledge of the two subjects, and an honest desire to give both their full play; those are difficult things to secure, but still if they be secured I do not see any impossibility.

3699. Would not the efforts of such a head master, if such a paragon could be got to exist, be greatly seconded by the more thorough organisation of the scientific part of the Universities. Supposing, for example, that your scientific teaching and your system of granting scientific fellowships and scholarships at

Oxford received what one may call a fair development, would not that enormously strengthen the hands of any such head master?—Yes, very much, and also if we had a matriculation examination in which that same principle of bifurcation should be fairly recognised. If a man could be admitted to the University by passing some examination in which certain great attainments should compensate in one line for deficiency in another, or in which you had the opposite principle, namely, that of cumulative attainments recognised, of course that would necessarily regulate the curriculum of our large schools, even in spite of a large amount of recalcitration on the part of the masters.

3700. I suppose as a matter of fact the public schools must follow the University?—Yes, certainly they do.

3701. In your last examination you rather expressed an opinion against conferring degrees in science. Will you be so kind as to state your grounds for that opinion?—I did it for this reason, that the B.A. degree is a thing that is understood just at the present moment, it is worth a great deal. And for just the same reasons for which I should demur to the plan put forward by Lord Lyttelton of taking two distinct schools for bringing up young people on different plans of instruction, so should I demur to the plan which gave two appellations, one to men educated by the route of science, and the other to men educated by the route of literary studies. The B.A. degree is a thing of considerable value, and I wish to keep what is of value in itself, only I wish it to be equally dealt out to lines of study which I think are equally deserving of it.

3702. You look upon the B.A. degree as the mark of an educated person, and not of an expert?—I do, that is all.

3703. But you would have no objection to have a system of scientific degrees open to persons who had taken the B.A. degree?—Certainly not; but I think that our present plan is preferable, as under it a man who has shown a certain minimum competence in literary studies has the B.A. degree given him by virtue of the scientific attainments which he superadds to that competence.

3704. But you have no objection to establishing scientific degrees, such as bachelor of science or doctor of science, to which he might proceed after he had taken the B.A.?—No; but I think that in the first instance he should be called a bachelor of arts just as much as any person who got it by means of mathematics, or law and modern history, or classics, for competence in which a man gets the B.A. degree at present.

3705. You spoke of science becoming a profession; in what direction do you contemplate science becoming a profession? Do you mean in teaching?—In teaching; the pecuniary rewards for teaching in large schools constitute careers to men; now many schools are getting scientific teachers.

3706. Do you think that the demand for them will become so great as to make science a remunerative profession?—I think that if we were to have, say such a matriculation examination as the one I have pointed out above, and a certain disposal of rewards, that would call forth necessarily in the way of reaction upon the schools a demand for such instruction. I may say, that since I gave evidence here a week ago, I have had a letter from a large school, asking if I could mention two young men for two places, each with incomes of between 200*l.* and 300*l.* a year, the one to teach chemistry and the other to teach physics.

3707. Could you accommodate more than the number of students that you stated you have, viz. 37 or 38?—With some little difficulty I think I could.

3708. Is there provision in the University for your extension?—It would be easy to add on a few rooms to my department as at present existing.

3709. Do you wish the collection which is now maintained in the museum to remain of an exclusively educational character, or would you like to make it



more extensive for the purposes of biological study?—I should wish it to do both; to be as perfect as possible in the way of furnishing means for students beginning from the very beginning, but I should wish also that certain particular lines of investigation should be thoroughly represented in it, that if certain accidents put it in our way to work up particular lines, say anatomy or ethnology, for we have particular facilities from our young men scattering all over the world and becoming great travellers as they do, or any other line of that kind, that we might have the means of doing so. I think it is of great importance that the University should not on the one hand try to make a collection which should vie with any great London collection, such as the British Museum, or even that in the College of Surgeons; but neither, on the other hand, should it debar itself from subserving the uses of scientific men as opposed to the uses of pupils.

3710. Are you not afraid that that would commit the University to an enormous expenditure, museums being very costly luxuries, if you go in for them on a large scale?—Our museum does cost a great deal, there is no doubt as it is.

3711. Are you not afraid of rather over-travelling in that direction if you go in for making a thoroughly scientific collection for the purpose of investigation?—My own feeling about the management of a museum is this, that exactly the same principle gives value to a museum as gives value to natural science as an engine of education. Unless there is some element of originality and independence, so to say, unless it can be said in that place you can do that thing to the greatest advantage, it scarcely answers its proper end. I think with a large museum such as you know ours is, and as the Commissioners can see it is by the plan. I have shown, it is indispensable that there should be something that could be better done there than elsewhere. I think that that gives a certain tone, and just as the fact of a man's working at original work gives a certain value to his teaching, whatever that original work may be, so the fact of a museum being a witness and a keeper of some particular fragment of scientific writ gives it a greater value in the eyes not only of the world, because that is of small consequence, but even in the eyes of the pupils and of the teachers in it.

3712. Then you would contemplate the collection of specialties in it of a nature such as the very magnificent collection of megalosaurian remains, which you know are the finest in the world?—Yes.

3713. Would you have it embrace subjects of that sort?—Yes; I would have such a subject as ethnology, or the illustration of any particular line of research that might have been carried on by any of the pupils or teachers in the place; that any person should come to that place saying, I know that I shall see all that illustrates that particular matter there.

3714. You look upon it that a certain minimum collection of important and special scientific objects would be of great use to the students?—Yes; and although a great deal of money is spent by the University upon the collection year by year, I do not think the expense need be so very great.

3715. (*Sir J. Kay-Shuttleworth.*) When you spoke of the bifurcation in secondary schools, at what period of the literary instruction should that bifurcation in your opinion take place?—I should say that, measured by years, all boys should be kept to the same course till about 16, and then when a boy had shown either that he had an entire incompetence to excellence in one branch, or a special capability on the other hand to excellence in that branch, then a severance of the boys under the same roof should be allowed.

3716. Are you aware of any experiments which have hitherto been tried practically of the position which instruction in science and modern learning takes in the great public schools?—I know that science has been put into the corner, and that it has been spoken of as if it were mere dilettanteism by people who speak evil of that which they are not acquainted with; but I think if that were set aside, and we had no

longer that way of depreciating a particular line of study, public opinion would gradually right itself.

3717. You are aware that, as one of the causes, very few head masters and very few masters have received any other than a literary education?—Yes.

3718. And that all their own personal preferences are strongly in favour of that literary instruction as a means of mental training?—Yes, I know it is so. On the other hand, we have the distinct testimony of persons who have had experience on the continent of the plan of local separation of scientific and classical schools against such separation. Such evidence you will find in print in the report which was given to Owen's College with the names of Principal Greenwood and Professor Roscoe appended to it.

3719. But reverting to the system of bifurcation which you would propose should occur at 16, you would I apprehend postpone anything like scientific education to that age?—No, I would not. I would certainly cause a boy to begin acquaintance with scientific matters much earlier than that, for the faculty of observation, the power of observing, is in all its vigour long before 16. Long before the faculties of reflection and ratiocination are in anything like ripeness the faculties of observation are well developed. A boy I should say at 11, or certainly 12, might be put through certain of the classificatory sciences, or one at least, viz. botany, and he might have a training in physics and a training in chemistry, and all boys alike should have some training in these before 16.

3720. Then before 16 he would be learning Latin and Greek?—I should demur perhaps to Greek. I do not think that all boys should be compelled to begin Greek at all. I should be quite content with the common basis that Latin does furnish for all boys alike, at least up to the period named.

3721. But few boys who have to learn Latin and Greek and the ordinary elements of an English education, some mathematics, and probably also modern languages, would be likely to learn science part before the period of bifurcation?—Although I began Greek much earlier myself I should not insist upon a boy beginning Greek very much before 16, or at all events 15. If he had his Latin thoroughly well worked into him, and if he had it properly taught him, he would find the mastery of Greek a much easier matter than it is ordinarily supposed to be. Certainly I say that all boys should have Latin, a certain amount of mathematics, and a certain amount of natural science, before the age of 16, whatever their future career upon the bifurcation plan might be.

3722. Do you contemplate the modern languages likewise being taught?—I should oblige a boy who elected for natural science to take up German as a compensatory thing as against Greek after 16.

3723. Does not the system of bifurcation involve there being in the same school a large staff of masters; for example, a master for instruction in modern languages, a master for instruction in English literature, and likewise a master for instruction in science?—I do not quite think that that need necessarily be so. There is a disadvantage certainly in getting a good science master who would be able and willing to take mathematics for the lower forms if he were a good science master; the fact of his having only the lower forms frequently for mathematics might put him in a position of something like inferiority with reference to his teaching of science, and put the science also in a position of inferiority, but I think masters might be found who would be able to teach both to advantage.

3724. But looking to the question of expense, supposing an endowed school had 1,000*l.* a year income, and the question were presented to the trustees how they could render the application of that fund most efficient, would not the great number of masters required by the system of bifurcation render it difficult for them to offer a sufficient emolument to the teachers of each subject to ensure their obtaining the highest teaching skill?—That I suppose may be

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22 July 1870.



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met in another way. If the system of bifurcation succeeded the number of scholars would increase, and the houses would pay the under master by the number of boys that would be attracted as boarders.

3725. In a great number of those endowed schools there are no houses. The masters are paid by stipends to a very considerable extent. They are not at all paid by fees, and the question which presents itself to the trustees is how they can render their teaching staff most efficient. My question, therefore, was, if you are to have so large a staff of masters as the system of bifurcation implies, can you hope to obtain the same degree of efficiency?—I should just say that I only answered the question with regard to what was the best possible arrangement. I could easily understand that there may be local conditions which do not allow of the establishment of houses, which I believe are looked upon as the great means for securing a good staff of masters, as they are the best way of paying people, and certainly unless you pay people well you will not get good men. I have no anxiety to criticize any of the recommendations of the Commission. I was only saying what I thought was to my mind the best possible plan of education, granted all favourable conditions.

3726. I have presented to you practical difficulties for consideration, let me present another form of difficulty, that such a school should exist in a great manufacturing district where the necessities of the trade and the public opinion of the parents induce the introduction of young men into the actual business of life not later ordinarily than 16, and seldom or never later than 18, and therefore there is a need to terminate their tuition before those ages; would you in such a case consider that it might not be a legitimate experiment to try whether in a school in which literary culture should consist of Latin and one or more modern languages, there should be superadded to that the scientific instruction which is peculiarly fitted to develop the material resources of the district?—Certainly; but then that would be exactly what I should contemplate for nearly all schools up to the period of 16. The point that you mentioned as the *terminus ad quem* is at the age 16, of which I spoke as my *terminus a quo*; and I should go further than that, and say that even in the Universities we should allow persons to become members of the University at 18 without Greek being a *sine qua non* if there were any compensatory thing brought up in place of it.

3727. But if it were regarded as a legitimate object to seek to raise the school age from 16 to 18, and if there were little hope that any but exceptional boys would go to the Universities, might not such a scheme of education as that which I have described be more attractive to parents and more useful to the class to which I have referred than one which would include Greek?—That is a question which I should wish to take some time to answer. What I do feel about it is, that there should be for the entire mass of English society one common substratum of literary culture, and Greek, which is the stumbling block, I should be glad to see removed, even for persons coming to the Universities if they wished it, and if found necessary.

3728. You are probably aware of the evidence which has been given of the slender amount of proficiency in Greek which is exhibited by students who come to the Universities?—I know that very well.

3729. That it amounts to a very large disproportion of failures?—Yes.

3730. When there is in the community a great demand for a knowledge of modern languages and of science, and it is admitted that the substratum of a sound education in Latin is desirable, such a course of instruction as that which I have described, which omits Greek, should be founded for a great manufacturing and commercial district?—Yes.

3731. Seeing that many professional men,—clergymen, physicians, surgeons, and men connected with the law, with limited means,—might desire to give their sons the benefit of such schools, is it not

nationally just and fair that the scholarships and exhibitions of the Universities should be open to persons so trained?—Yes, certainly, I should be quite in favour of that. The only point that I object to is this (and it is on the same sort of ground that I do not wish to see the letters B.Sc. substituted for B.A.), the recognising by any formal enactment what may seem to be the inferiority of one line of instruction, or one class of school to another; for I am very well aware that parents are very sensitive to these kind of things; and if parents are given to understand that this kind of school is intended for professional people, and so on, there is a peculiar feeling which acts powerfully on parents spoken of by two French writers, Demogeot and Montucci, in their report, *sur l'Enseignement Supérieur dans la Grande Bretagne*, under the title of a *vanité très Anglaise*, a vanity characteristic of the English, which they subsequently expound by what I believe is an English word, "snobbisme." Considerable weight is laid upon the existence of that national failing by those gentlemen with reference, it is true, to another class of persons; still it acts very strongly upon parents, and I think that it will operate against any school started professedly in the interest of one section or stratum or level in society.

3732. If that feeling should be now prevalent, without desiring in the slightest degree that the long-prevailing homage to classical studies should be diminished, is it not desirable that the feeling in favour of scientific studies should be greatly increased?—Certainly, and that I think it may be by the system of bifurcation at the matriculation examination of the Universities, by necessitating all schools to pay attention to it; and then, with respect to scientific education, it would, in spite of all reluctance on the part of masters, assume and maintain its proper place in the school curriculum.

3733. You are at present, as you have stated in your evidence, hopefully preparing in the University a class of efficient scientific teachers, and those men will generally have secured the literary attainments of the University, and will therefore be able to hold their place in endowed schools with as much respect among their pupils as the literary masters; will not the introduction of that class of masters into those schools tend greatly to improve the public feeling with respect to the efficiency of scientific teaching as a means of mental training?—Yes; I think that I gave some evidence when I was here before to that effect, that persons who are experts in both lines act as missionaries or advertisements of the value of both, and especially of course as advertisements of the value of that which is considered to be a secondary subject by some.

3734. Supposing that the work of training scientific teachers were considerably more advanced than it is at present, and that the Universities had likewise placed more exhibitions and scholarships at the disposal of proficients in scientific instruction, do you not think that those things would tend greatly to change the condition of public opinion upon the subject of the relative merits of scientific and literary instruction?—Yes, I think so. There are a great number of conditions and helping causes besides, which I have come to think worth far more in that direction even than that, such an one as the change that I mentioned in my last evidence, to the effect that a person who had got honours in any one line of study should on that account be still free to throw his energies into any other. At the present time there can be no doubt that the natural sciences have a very great influence and effect upon all thought whatever. There may be a reaction some years hence in the other direction, but there can be no doubt that a young man who simply goes into literature at the present time must feel himself very considerably at a disadvantage if he is devoid of all natural science training. Hence, if such a person coming up from any one of the schools which, by virtue of their head master's reluctance to go into natural science, or any



other cause whatever, has thrown natural science into the background, attains whatever literary honours the University can give, and if then he takes stock of his condition with reference to the outside world, he, being active minded *ex hypothesi*, is exceedingly likely to throw himself into natural science, but he has not, according to our present artificial restrictions, the means of getting any honours in it, because he would have spent all his time in getting honours in literary studies, and there would be none left. If such a person as that were to avail himself of the means that we now have of obtaining proficiency in natural science, the fact of such a person thinking it worth his while to study natural science would be I think as real and as valuable a testimony to its value as any other that could be paid to it.

3735. Quite apart from the question of bifurcation or other constitution of the school, could you convey to us your opinion as to what scientific subjects can be most beneficially taught in an endowed school founded for middle classes to prepare for the University?—I think that boys should very soon and early be introduced to those subjects which they can study with great advantage when young; that is to say, the sciences of observation. I should say that boys should be worked through botany, as being an excellent classificatory science, and one readily studied, and that is perhaps a thing which boys might be made experts and adepts at at a very early period. Then at the same time boys certainly should have a certain minimum of mathematics, and then they should have superadded to that a certain minimum of physics and of chemistry; all those three scientific subjects, with a background or basal ground of mathematics, can be attained by a boy before the completion of 16 years.

3736. You would not exclude, in a wide sense, physical geography?—No, certainly not. A course of such things as the rationale of tides and winds and heat, and the distribution of land and sea, as affecting it, would be an exceedingly good stepping stone from botany to the more precise physical sciences.

3737. Have you reflected at all upon the nature of the scientific instruction which would be given under all the limitations which now exist in primary schools?—No, I have not.

3738. (*Mr. Samuelson.*) Is it not the case that great doubt has been expressed in France with regard to the success of the plan of bifurcation?—I am not quite sure as to France. I know what has been said of Germany, but I do not know what has been said in France.

3739. But are you acquainted with any schools either here or abroad in which it has succeeded, and has not been found to be subject to the disadvantages which are anticipated of it by the Endowed Schools' Commissioners?—No, I have not, but upon the general principles of human nature I can understand how failure can be brought about, as it is much easier to make a thing fail than to make it succeed; all that is wanted is the wish to make the thing succeed.

3740. You would not, I presume, wish us to abandon the hope of making it succeed?—No, certainly not. My bifurcation is not a bifurcation that takes place until a boy gets to something like maturity; it is when a boy is mature enough on Sir James Shuttleworth's plan (see 3726), to be launched into life at 16 years of age, when a boy acts in posts of considerable responsibility, like those of clerks in offices. I do not wish to see the bifurcation before the completion of the 16th year.

3741. At any rate you would place 16 as the very lowest limit of age at which you would like to see this bifurcation take place?—I think so.

3742. Referring to the report of Messrs. Greenwood and Roscoe, did not that have relation rather to a different class of individuals, namely, to those who are supposed to have received no literary training whatever beyond that which could be obtained at a primary school?—I beg your pardon. They contrast what are called the gymnasia with the realschulen of Germany; the gymnasia there correspond to our public schools, I apprehend, as nearly as anything can correspond.

3743. But the realschulen on the other hand would correspond with something which we have not yet in this country, but which would imply no literary training whatever, or scarcely any?—On the other hand, there are institutions which they call *realgymnasias*, not *realschulen*, such an one as the Frederick William Old Cologne Gymnasium, in Berlin; and a memoir has recently come into my hand in the shape of an address by Professor Pettenkofer, of Munich, whose name is well known as a chemist, wherein he contrasts the relative value of those schools, and the *realgymnasias* are spoken of as being established institutions in Germany, as opposed, I think, on the one hand to the realschulen and on the other to the old humanistic gymnasium.

3744. And that is rather the model which you would wish to see followed by the Endowed Schools' Commissioners?—Rather the data given me there would make me think that the plan of superadding science to the humanistic gymnasium was the true one to take, but the plan has not been adopted to any great extent, or exactly, in Germany. I believe it has been tried in the one that I just now mentioned.

3745. Then the third class is the one to which you would lean?—Yes; I should wish to see schools with a *mixed curriculum*, *simultan* is the German term.

3746. I think if I remember rightly the verdict of Messrs. Greenwood and Roscoe rather was to this effect, that men having no literary training whatever were not likely to be so successful in the capacity of men of science as those who had received a literary training in addition to scientific instruction?—Certainly they were in favour rather of the plan of keeping the two subjects together, and requiring a certain amount of literary culture from all persons.

3747. When you objected to the separation of literary and scientific studies you intended, did you not, to speak in the first place of secondary schools of a low grade?—Yes.

3748. And in the second place of those which prepare for the universities?—Yes.

3749. But you did not, I presume, intend to express an opinion adverse to the establishment of high and special schools of science in those localities where there was a demand for scientific, as distinguished from combined scientific and literary instruction in universities?—No; I did not mean to object to that.

3750. (*Chairman.*) Is there any other point upon which you could favour us with your opinion?—There is only one thing that I should like to mention. On my former examination I said something about the plan that we had of students not attached to colleges, and I gave a certain number, something under 100 as being their present numbers. When I returned I obtained a number of copies of the annual report of the delegacy of those students, which one of the delegates gave me, in which all the facts are stated, and which I will hand in to the Commission (*delivering in the same*).

The witness withdrew.

Adjourned to Tuesday, the 15th November next, at 12 o'clock.

G. Rolleston,  
Esq., M.D.,  
F.R.S.

22 July 1870.



Tuesday, 15th November 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D., Sec. R.S.

The Rev. MARK PATTISON, B.D., examined.

Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.

3751. (*Chairman.*) I believe that you are Rector of Lincoln College?—Yes.

3752. And also examiner in the classical school of the University of Oxford, and examiner in logic in the University of London?—Yes.

3753. The Commission will be glad to learn your views with respect to the promotion of science in the University of Oxford, and the means by which you think that it might best be promoted it?—I should divide what I would venture to say into the three heads—promotion by teaching, promotion by examination, and promotion out of the endowments of the colleges.

3754. Do you think that there is any probability that the University will itself come forward with a professional opinion upon this subject?—I wish to state to the Commission, in order to stand right before them, that I do not feel myself to be one of those persons who are being at this moment driven by a communication which has been made to the University by the Endowed Schools' Commission. Such a communication has been made, and it has caused a very considerable difference of opinion in the University. Some wish to yield to the demand there made, which is a demand that the University degrees, and consequently its emoluments, shall be open to persons without Greek, perhaps with Latin, but at least without Greek. A great division of opinion has arisen in the University in consequence of this demand, and some persons wish to yield to it, other persons are for resisting it. I confess that I do not like to feel that the University is in that position, because I, myself, and some others, have for years been in the position of urging upon the University that they should spontaneously come forward and take the step which is now proposed, that they should institute a complete course of scientific instruction, which should be entirely detached from the literary instruction in the University.

3755. Will you proceed to give us your views upon the promotion of science, by means of examinations?—The great point of difficulty at the outset is, as to whether the scientific course should form a part of, and should be in some way or other combined with, a general course of instruction, or whether it should stand alone. A scientific course can be combined with literary training, either simultaneously or consecutively. The examination for the Second Bachelor of Arts in the London University, combines science with classics simultaneously, that is to say, to get a second B.A. degree, the candidate must pass in Latin, and in Greek history, at the same time that he passes in mathematics and physiology. A failure in any one of those three subjects, a failure in Greek alone, in Latin alone, or in Greek history alone, would be a failure to obtain the degree. In the University of Oxford, at present, science is combined with classics, not simultaneously but consecutively. There are two distinct examinations held at separate times. The B.A. degree is now given after the purely science examination in some two branches of physical science; but then, in order to be admitted to that examination, the candidate must have passed an earlier examination, called moderations, at which both Latin and Greek, and Latin composition, are required; he could not enter upon his scientific course without having passed

that examination. Consequently, our system, as it stands at present, is, so far as science is concerned, a system in which science is combined with literature, not simultaneously but consecutively.

3756. Is there nothing but classical literature required for moderations; are there no mathematics?—Yes, there is a certain quantity of mathematics; a very elementary quantity of Euclid and algebra is required. Prior to the existing situation, which is created by Lord Lyttelton's letter, there had been efforts on the part of certain persons in the University to still further break down the classical requirement, to push back moderations in their preliminary examination to an earlier period of the student's career, and to diminish the quantity; but I think it was thought hopeless in the present state of University opinion to propose in the University itself that a curriculum should be open which should consist of science from the beginning. What I would venture to propose to the Commissioners is, that it should be recommended to the University that such a course should for the future be open. I am not able to say anything about the schools. I do not feel that I am qualified to offer an opinion as to what should be done at school; but whatever is done at school, I would propose that when a young man comes up to the University, it should be open to him to matriculate at once as a scientific student; that he should not be checked in that career at any point by a classical requirement; that if he chooses to enter as a scientific student, the University should know nothing of him but as a scientific student, and that it should not throw, what I may call, a bar in his way by seeing whether he knows anything of Greek or Latin. A young man does not usually come to the University until 18, more usually it is 19, but 18 is the earliest age, and by that time I think that a good school might have laid a sufficient groundwork in literature, either classical or modern, and that there would be quite enough to do in the three years during which he is in the University, to conduct him through a course of mathematics and natural science.

3757. Do I rightly understand you, that you would allow a young man who had had no literary training whatever to enter himself on the scientific side in the University of Oxford?—As far as the University is concerned, I would have the University take no cognizance of that matter if he chooses to enter as a scientific student. I would have the University take no cognizance of any literary attainments. Whether you should require the schools to certify themselves in any way of a man's literary attainments, is a different question; but I would not have the University put a barrier in his way at the beginning.

3758. If a young man were disposed to study both classics and science, would you throw any obstacles in his way?—Certainly not.

3759. It is your opinion, is it not, that there should be no matriculation examination whatever?—Yes, that is in order to avoid the waste of time which now occurs in preparing for subjects which are not afterwards to be studied.

3760. When would your first examination take place?—At the end of the student's first year. Considering his course to be a three years' course, I would put it at the end of the first year.

3761. You would have one examination for the



classical students at the end of the first year, and one for science; would you, at that period, divide the scientific examination into more than one branch?—At that period, I think, the scientific examination ought to be, not special, but general and elementary.

3762. Will you be so good as to inform the Commission what, in your opinion, ought to be the nature of the first examination on the science side?—Speaking generally, I think it might be composed of three elements. First, mathematical; and I lay great stress upon that, because in our present physical school we have an examination which does not directly require any mathematics. Of course, indirectly, it is impossible to pass an examination in either of the branches of natural science without involving a small amount of mathematical knowledge; but there is no direct examination in mathematics—no branch of mathematics is required of the candidate. I would lay stress upon that, because, as an initial and elementary examination, I think the future students of natural science should be required to show a competent acquaintance with the elements of mathematics. I would not push it very far. I know it is a doubt with some mathematical friends with whom I have talked it over, whether it should include the calculus; that I cannot say, but it should not go beyond that, I think.

3763. Is it your opinion, that it should not include the differential calculus?—I should have thought not, but I find that some of my mathematical friends think it should; and, of course, I am not able to offer an opinion in opposition to theirs.

3764. Besides mathematics, what ought to be included in the second branch?—In the second branch of examination, two, at least, of the leading departments of physical science should be represented, I think, and I think it should be left free to the candidate to name the two; but the details of that, of course, a professor of physics would be able to give an opinion upon, which I could not.

3765. Is there any one branch of physical science which you consider indispensable, such as mechanics, for instance?—I should myself have thought that mechanics had the principal claims, but I would leave the choice free, because I can conceive cases where a young man, from circumstances, has had a chemical training, and would prefer to offer chemistry rather than mechanical philosophy. The only point that I would remark, with regard to that, is, that I think that the examination in the physical branch of this preliminary examination should be very elementary, should be only in the principles of the science, and should not be conducted by way of experiment or operation.

3766. And you would not require a general knowledge of physical science, but merely an acquaintance with two, or, at most, three, branches?—Generally speaking, I should have said that that would be sufficient, but I think that rather a matter of detail.

3767. Is there any other subject which you would include in this examination?—Considering that all literature and language is excluded, on principle, from this examination, I think it would be desirable to include in it the elements of logic. That is done at the London University, and I think is a very valuable part of the London University science degree. It is exacted at the London University, not only of the second Bachelor of Arts, but also of the Bachelor of Science, the Master of Arts, and the Master of Surgery.

3768. You think that a certain amount of Mill's Logic should come at this early period of the science examination?—I put it at the end of the first year, because logic is already included in the University examination called moderations, and we find no difficulty in getting a minimum of logic at that period, and also because I have provided no other place for logic at the later stage.

3769. Does your experience of the examination in the University of London lead you to form a high estimate of the value of logic being included in the examinations for young men studying scientific subjects?—Yes, decidedly so.

3770. In this examination, would you contemplate

having any honours?—No, in this examination, I would have no honours.

3771. Would any other examination, according to your scheme, be necessary for the first degree?—At the end of a student's course, and as a requisite for the degree, I would have, on the science side, a distinct science examination, and that should differ from the preliminary examination in being highly specialised.

3772. Would you divide this examination into three or four different branches?—Yes, into three or four special schools.

3773. Do you consider that the obtaining honours in this examination should entitle the candidate to a degree?—The passing in honours, and it should only be an honours' school, but divided, say, into four classes (I have said four because that is the number at present in use in the University), should entitle any person who passes in any of those four classes, even in the lowest, to a degree. But I would not prohibit the candidate from seeking honours, and obtaining them, in any number of the schools.

3774. Or also in the classical examination?—And also in the classical examination.

3775. Would you confine the degree in arts solely to the classical examination?—I do not lay much stress upon the name given to the degree, but I think it would be found in practice useful that those who have passed the classical curriculum should be designated as Masters, or Bachelors of Arts, and that those who passed in the science curriculum should be designated as Masters or Bachelors of Science.

3776. Am I right in supposing that, in your opinion, there should be no pass examination for a degree, and that no one should take a degree who had not obtained honours?—That no one should obtain a degree who had not obtained at least a fourth class. Taking the standard as it exists at present at Oxford, a fourth class does not imply any unattainable amount of knowledge.

3777. Does the fourth class usually comprise a considerable number of students?—The fourth class in the classical school often contains a large proportion of those who come up, but not nearly the same number as that of those who pass below it, and yet obtain a degree.

3778. Could most students, with a fair degree of industry, obtain a fourth class in the classical examination?—That is rather a difficult question to answer, because there are a great many students who ought never to have been students at all, and for those, I believe, it would be utterly impossible to obtain a fourth class; it is impossible for them ever to obtain a degree even at the low point at which the pass is at present fixed.

3779. However, you would not fix it so high that young men without any special talents would be unable to obtain a degree if they exercised such industry as might fairly be expected from them?—I would not fix it higher than the standard at present of the first Bachelor of Arts in the London University.

3780. Will you enumerate the number of schools that you would recommend?—That I could only venture to do in outline, just to indicate my view; the principal point of the system would be, that no main branch of science should be omitted in the programme. Probably, in practice, if this scheme were set on foot, it would come to this, that from time to time the number of schools would be remoulded in order to suit the existing state of knowledge. I should propose, at present, that there should be one school of pure mathematics, but in order to avoid the objection that is made that pure mathematics alone do not give a sufficient training without some material facts, I would include, say, astronomy, in the school of pure mathematics. A second school should be a school of physics, which would include mechanical philosophy in its various branches, and heat, treated mechanically; optics, perhaps, and acoustics. A third school should be constituted upon the biological sciences, physiology, and morphology, and a fourth school should embrace the chemical sciences, both organic and inorganic chemistry, and

Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.



Rev.  
M. Pattison,  
B.D.  
—  
15 Nov. 1870.

heat, treated chemically, and light, treated chemically, electricity, magnetism, mineralogy, and crystallography. That is a mere outline of a division which, of course, is capable of being improved or modified, but may just represent the nature of this scientific examination.

3781. Would you make any provision for branches of science not included in those four schools?—There are important branches of science which, I think, the experience of other institutions which have gone further in examining in science than we have, leads one to think cannot be successfully included in a degree examination, such as, generally, the classificatory sciences, zoology, botany, geology, and physical geography, which are very important points of knowledge, but, from their nature, not so capable of being scientifically explored by an examination as the others. I think it would be desirable that the universities should be represented in them, and that the students should be encouraged to pursue them; but that, I think, might be done by extra prizes, such as scholarships and fellowships. Botany, of course, admits of asking most minute and direct questions, and of getting direct and exact answers, right or wrong, and it is one which admits of a very satisfactory classification of the student's knowledge, but not, I think, of a satisfactory combination with the four great subjects, as I have sketched them out, viz., pure mathematics, physics, physiology, and chemistry.

3782. What would you regard those degrees as guaranteeing, or of what would you regard them as evidence?—The degree, inasmuch as it would be attainable upon the fourth class, would, taken by itself, indicate only a special training in that special subject; but the honour, which would be preserved in the Calendar of the University as a first class in any of those schools, ought to indicate as high a degree of attainment in the subject, as two years special study of it could be expected to produce.

3783. In addition to those degrees, what other degrees would you recommend?—This is a point on which I feel more doubtful; but the London University succeeds in carrying on its students beyond the second B.A.; it has an M.A. examination, and a Doctor of Science examination, and medical examinations. How far a university situated in the country can ever become a medical school, is a matter, I believe, of great doubt among medical men. I believe, as far as I can make out, that the best opinion amongst medical men is, that Oxford could do more in the way of a preliminary study of science than by a direct study of medicine. However, as we do give degrees in medicine (and I don't hear that it is proposed to give up doing so), and as we do examine in medicine, and there is rather a stiff examination in medicine, I do not propose to abolish this examination; but I would allow a science M.A. or B.A. to go on, and be further examined for his profession for medicine, on the scientific side, and for law, on the classical side.

3784. Would you have any further degree in sciences, such as the biological sciences and chemistry?—I feel very doubtful about that. The other part of what I proposed appears to me so feasible, and so nearly within our reach, that I should not like to complicate it with what might be the more doubtful proposal of having a Doctorate of Science, but I think it would be possible, if the Mastership of Science were found to work well, to institute a still further specialised examination which should lead up to the Doctorate of Science.

3785. Have you thought about the advisableness of including such subjects as engineering and chemical technology?—I have a great ambition that the University of Oxford, which is so wealthy, should extend its hand in every direction through the country, and I see no reason why it should not offer facilities for outlying technical branches, too, but it would be a novelty. We have not done anything of the kind as yet.

3786. To carry out the scheme of which you have furnished us with a sketch, it would be necessary, would it not, that great additions should be made to the teaching apparatus of the University?—The

Commission are aware that we have at present the beginning of a school of natural science, and we have several professors, who, as I understand, are very eminent in their respective branches, but we have not, in any one of the branches, more than one professor. We have one professor of physiology, we have one professor of chemistry, we have one professor of pure mathematics, and of natural philosophy we have two; and, to carry out my proposed scheme, that would be a wholly inadequate staff.

3787. Has not the University made very extensive provision for scientific teaching, by the erection of museums and laboratories, of late years?—We have spent many large sums of money in that direction, and we maintain the museum, with its appurtenances, at a very large annual cost. The cost of the museum to the University is now about 2,000*l.* a year, exclusive of the salaries of the professors. I speak of the mere maintenance of the physiological and chemical departments. I do not include the additions made from the University chest to existing establishments.

3788. If more teaching apparatus is required, have you resources for providing it?—I consider that we possess, in the college funds, ample resources, without trenching at all upon the work which we at present do on the classical or literary side.

3789. Is it your opinion that a larger proportion of the college endowments is applied in the department of classics than is required for the thorough cultivation of classical literature?—That is the case, and that it is so, is owing to the mode in which the fellowships are bestowed. The fellowship, I may say, was originally a means of maintaining a student (I may call him a student, although he had taken the first degree), a Bachelor of Arts in Oxford, to study for his M.A. degree, and he had in this fellowship a maintenance, and no more. As the estates gradually increased in value, by the general increase of property in the country, it gradually became the custom to divide the surplus rents. Then, in a way which I need not recapitulate, which is well known to the Commissioners, it became the custom to allow a fellow after election to be non-resident, and to receive that dividend, and the consequence is, that out of the total number of fellowships in the University, by far the larger number are held by persons who have ceased either to study or to teach, or to do anything whatever in the University except coming down occasionally to vote at a college meeting.

3790. There are about 360 fellowships at Oxford, are there not?—The number has been reduced to about 360, and they are not all of equal value; the value in different colleges being dependent upon the total amount divisible as dividend in that college, and upon the varying rent of the year, according as it is a good or a bad year, but they may be said to range generally from the value of 200*l.* to 300*l.* a year. Of those 360 fellowships, the number engaged either as professors, or as college tutors, or as private tutors, or as bursars, or as college officers, in one way or another, I reckon approximately (for it can only be ascertained approximately, because it is a variable number), is under 100: out of the 360, I should say that it was considerably under 100, but it may be 100.

3791. Do I understand that your proposal would be to suppress all fellowships the holders of which are not employed in teaching, or in doing University work of some kind?—I am afraid that if I were to say that 260 fellowships should be suppressed, I might throw ridicule upon the whole proposal. I should not like to be asked to say that.

3792. Is it your opinion that a considerable proportion of them might be suppressed?—I think that we are all prepared for a further very large suppression of fellowships, but there is a great difference of opinion as to how far that should go.

3793. But you are of opinion that men's minds are prepared for a very large suppression of non-working fellowships?—I think that a large majority of the residents in the University would be in favour of a further large suppression of fellowships.



3794. Of the total number of fellowships, how many have been awarded for attainment in mathematical and physical science?—I think somewhere about 30. It is impossible to assign the number exactly, because there are at present on the books of the colleges men who came in, not by examination, but in the way of succession, on the old system of succession, but whose claim to a fellowship rests on mathematical attainments although they did not obtain it by mathematics.

3795. Has provision been made for an increase in the number of fellowships awarded to mathematical and physical science?—A process is going on at this moment, under the original ordinance of the Commission of 1854, which is not yet exhausted, by which endowment is constantly passing from the classical side of the University to the natural science side; but that process is slow, and the amount is small.

3796. When it has come into full operation, it would still, I presume, leave a great majority of the fellowships awarded solely for classical attainments?—Yes. The number of fellowships remaining to be suppressed, under the ordinance of 1854, I am not able to state, but it is very small.

3797. Are you further of opinion that there is a waste of teaching power by the colleges, in so far as each college undertakes the exclusive instruction of its own men?—There is a jealousy, which is unavoidable from the constitution of the colleges. A college does not like to be thought unable to give tutorial instruction to its own men, and that leads, on the one side, to imperfect provision for instruction, and, on the other side, to a superfluity of the same kind of instruction.

3798. Are no mutual arrangements made by any of the smaller colleges?—I am happy to say, and this is one of the greatest improvements that we have made of late years, that within the last three or four years five or six of the smaller colleges have combined for tutorial purposes; but that combination is not a statutable combination, nor a permanent one, it is not even sanctioned by the respective colleges; it is entirely a personal combination among the tutors of those colleges, by which they agree to reciprocate their pupils, and that has led to a great improvement in the level of instruction. It has enabled one man to specialise himself and devote himself to one branch, and it economises labour generally. I should like to see that system put upon a systematic and statutable basis, and extended throughout the University.

3799. You have no fears that classical learning would suffer from a suppression of a portion of the fellowships now awarded for classical learning?—I have long been of opinion that the bestowal of a fellowship, or a pension of 300*l.* a year, to a young man of 24, for obtaining a first or second class in the classical schools, is an expenditure of the University funds which produces no result, in respect of the encouragement of those studies, beyond what might be produced by the honour alone. I think that we should have exactly the same amount, in quantity and quality, of classical study if we had no non-resident or prize fellowships.

3800. Supposing that a considerable number of the fellowships were suppressed, what would you do with the funds so obtained in the way of endowing science?—My proposal would be merely an extension of the system inaugurated by the Commissioners of 1854, which was to allow the non-resident fellowships gradually, in the lapse of years, to pass into permanent endowments for practical teachers and professors, either resident in the University or dispersed about the face of the country. The difference in principle, as to the bestowal of the money, would be simply that instead of bestowing the pension as a sinecure at 24, retrospectively and with reference to past attainments, I would bestow it prospectively, with the obligation to pursue, in some tangible and measurable shape, the subject for acquirement in which the pension was bestowed.

3801. The total number of scholarships and exhibitions is large at Oxford at present, but is not a very small proportion given to students of science?—As nearly as I can estimate, the sum annually spent

on students in scholarships and exhibitions, is about 35,000*l.*, and of that a very small proportion is at present bestowed upon science students.

3802. Are you of opinion that the number of scholarships granted for classics is larger than is required?—The number of scholarships granted for classics is larger than is required by the interests of classics. When I say that it is larger than is required, I do not mean large in proportion to what is bestowed on natural science, but larger than is necessary to promote the study of classics, and that arises again from rivalry between the colleges. The colleges may be considered, with respect to able students, as rival purchasers in the same market, and they go about the schools bidding against each other for the best scholars. The smaller colleges, which have not the inducements which the larger colleges have to attract students, first raised their scholarships to 80*l.* a year, 40*l.* being the previous average, gradually raising them to 80*l.*, and we now find that 80*l.* is not sufficient, that we cannot compete with the larger colleges at 80*l.*, and we are going on to 90*l.* and 100*l.* in order to get students of tolerable ability.

3803. Do any of the colleges grant scholarships to students without requiring, what you consider, sufficient attainments?—There is only a certain number of students in that rank of life, and who are able to afford the expense of a University course, produced every year, and I think I must say that we have found that we are not able to fill the scholarships, all round, with young men of sufficient ability to warrant their having this large amount of assistance in their college career.

3804. What remedy would you suggest for this state of things?—The only remedy that I can suggest is, that there should be a general examination once a year in the University for scholarships. An examination of the same character, I do not mean in the same subjects, but of the same character, as the Indian Civil Service examination, which should be open to all the world, and that, say, the 40 or 50 best students who came out at the top in that examination should have the scholarships for that year awarded them, and they might then afterwards be distributed among the colleges in some way to be agreed upon.

3805. As the number of classical scholarships decreased, would you increase the number of mathematical and science scholarships?—I would increase the number of mathematical and science scholarships, not by creating them all at once, but by allowing them to grow as the demand grew.

3806. At present is it not probable that there would be a sufficient number of well qualified candidates for any great increase in the number of science scholarships?—There certainly would not, there being few schools at which those subjects are taught.

3807. Will you now favour the Commission with your recommendations with respect to the teaching of science?—The scheme, of which I have drawn out an outline, might be called the scheme of a graduated professoriate. Although the name does not exist, the thing exists in rudiment with us already; it would be merely to develop further, and to apply to physical science the system upon which we are beginning to act on the classical side. A young Bachelor, or Master of Science, as soon as he has taken his degree, might, if he chose, go out into the world to his profession, or he might, if he chose, stay in the University; but if he stays in the University for the purpose of giving up his time and spending his life as a teacher of science, he ought to be justified in looking forward to a career and to a provision in life. The great defect of the old tutorial system, out of which we are just emerging in the University, was that a tutor spent in tutorial work the first 10 or 15 years, the best years of his life, during which he was making a very handsome income by tuition, but at the end of that time, when he wanted to settle in life, he had no means of doing so; for if he married he had to give up his fellowship, and lost his tutorship, and he had no profession on which to fall back; consequently, he was obliged to go into orders and take a college living. That was the old system. Now, it is

Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.



Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.

found necessary to give up that system. We find, even as things are at present, that we can go on no longer upon that system; we must be able to offer a career to our young teachers if they will devote their lives to teaching in the University. This scheme, which I have called a graduated professoriate, is merely intended to secure a career to men who so devote themselves to teaching. A young Bachelor, or Master of Science, would then say to the University, "I am ready to take 'pupils,' and the University should say to him, 'We will give you a small stipend of 60*l.*, or 80*l.*, or 100*l.* a year, and you shall take pupils, and receive fees from 'them.' He would, in the next two or three years, very soon ascertain whether he could get pupils, and whether the work suited him, and whether he was willing to commit his future to a university career. It would then be open to him, if he distinguishes himself as a private tutor, or *répétiteur*, to become a candidate for an inferior grade of professorship (what I may call a sub-professor, or a tutor, the name is unimportant). In the first instance, I imagine that he would be pretty well occupied in preparing the candidates for the preliminary examination which I have sketched. At the end of two or three years, if he became a sub-professor, he would be in some special faculty, his pupils would then be of a special kind, and he would have pupils who were preparing for their final examination in some one of the special schools. He should then receive such a salary as would enable a young unmarried man to live in the University. The position of the highest grade should be that of professor, and the number of professors, I think, need not be fixed, but might vary from time to time, according to the demands of the leading subjects in the final examination schools, the mathematical, the physical, the physiological, and the chemical; but these professors should be the most eminent men who can be selected out of the body of young teachers, and they should be provided for sufficiently to enable them to marry and live and settle in the place.

3808. According to your views, would those young men, under whatever name they are called, whether teachers, or tutors, or sub-professors, teach in connexion with the professors, or would they be allowed to teach according to their own discretion?—On that point there is considerable difference of opinion. Some of my friends think that sub-professors and professors cannot work together. I think that a matter of detail which would work itself out between the younger man and the older man. There will always be, and there are now, plenty of matters of dispute and difficulty between the various teachers, and there would always be so; but I think that those are things which practice would make smooth.

3809. Should you be disposed, in any instances, to recommend the appointment of more than one professor in precisely the same subject?—That, I think, would come about in this way, that there must come an age, somewhere between 50 and 60, or say at 60, when a professor ought to be released from any obligation to appear in the chair, but I would not superannuate him, and put him upon a mere retiring pension, unless he wished it. I would leave him his professorship; he might be very useful to science long after he had lost a taste for teaching it, and, in that case, a co-ordinate professor might be appointed, side by side with him, who should perform the duties of the chair.

3810. You would not, I presume, have, for instance, two professors of chemistry teaching both the same branch of chemistry, and, so to speak, competing against each other for students?—I think it would hardly be advisable, in any case, to have two professors of precisely the same part of the same subject, but, in so large a subject as chemistry, or so large a subject as physiology, in each of which we have only one professor at present, I believe both professors, both Sir Benjamin Brodie and Professor Rolleston, would be very glad to divide their subject with another man.

3811. You consider, do you not, that a number of new chairs of science would be desirable?—The obtaining, by the University, of some 20 or 30 eminent

men of science would be a great boon to the place. There is plenty of teaching energy amongst the young men, but owing to there being no future for them, to their knowing that there is no career, and that the more thoroughly they throw themselves into the teaching of one subject, the less hope they have of succeeding in another profession, their ardour is damped after a certain time. After a man has passed 35, it is found that his teaching energies flag, and he has not replaced them, that is to say, their place has not been taken by the interest of scientific research, and if we could have in the University at once some 20 or 30 men who possessed the true spirit of scientific research, I think it would be a great boon to the *esprit* or the temper of the place.

3812. Would you propose that the most important chairs should be more highly endowed than they are at present?—I think the highest endowed professorship in the University (the theological excepted) is the Sanscrit, which approaches 1,000*l.* a year. On the scientific side, the highest endowed chair is, I think, the physiological, which Professor Rolleston holds, and that is 800*l.* a year. Looking to the expense of house rent and living in Oxford, I do not think that a man can bring up a family in Oxford on 800*l.* a year.

3813. You think that the influence resulting from the introduction of a considerable number of eminent men would have a great effect upon Oxford generally?—I think it would be exactly what we want, to effect the object on behalf of which I have been arguing now; that it would not do for us to wait until the pupils came to set up a board of teachers. I think if we got eminent men in their respective departments, they would immediately attract pupils in those departments.

3814. If there were eminent teachers, you think that there would be no lack of students?—If there were eminent teachers, considering that the expenses of the place have been so materially reduced by permission to students to lodge out, I think that there would be no lack of science students.

3815. You contemplate, do you not, as an ultimate measure, that the various branches of science should be grouped together, and located in special colleges?—That is part of a very wide question, that of academies in science. In order to give completeness to the appearance of the scheme, I wish to indicate that as a mode in which I think the college endowments could be most efficiently brought to bear upon science. The endowments that I am proposing to convert to the purposes of science do not exist as University funds; they are not University funds, they are collegiate funds. Each college already constitutes, for a great variety of purposes, a corporation; and I would only propose to superinduce upon the already existing corporate body a given scientific character.

3816. What is the number of mathematical and physical professors in Oxford at present?—Eleven, I think, is the number.

3817. Have you formed any idea as to the extent to which you think this number ought to be increased?—Looking to the four schools that I have sketched out, the school of pure mathematics would, I think, require three leading professors. The physiological school, I think, cannot do with less than two. I say that on the authority of Dr. Rolleston. I have often heard him say that he should like to see another man appointed by his side. And in the chemical school I should hardly think that three would be sufficient. And then there are the outlying subjects: zoology is not represented at all; in botany there is one professor; and in geology there is one professor at present; but as I said just now the process must necessarily, on account of the mode in which the funds are to be derived from colleges by the suppression of fellowships, be a gradual one, and those professors, even if they could be found *en masse*, could not be provided at once; they must grow. Supposing that we got one eminent man in one department, he would draw a number of pupils, and then it would spread; another man would come, and he would draw



pupils: and so we should see in what direction the call was most urgent for the increase.

3818. Many of the professorships are very poorly paid at present, are they not?—Many of the professorships, both on the scientific and on the classical side, are poorly and inadequately paid.

3819. Probably the first application of any available funds would, in your opinion, be to increase the stipends of those professors to an adequate amount?—That would be the first application of the funds as they were set loose.

3820. Is it not a fact that some of the professors at present have either no classes, or very small classes?—That is the popular objection to the increase of the professoriate. It is very obvious to say, "Here you have a very eminent professor who is lecturing, or ready to lecture on such a branch, and but one pupil has come." That is the fact; but that is owing to the narrow constitution of the examinations as they stand at present. The students, naturally, will only attend those subjects which help them in their examinations.

3821. Are your views, generally, as to non-resident fellowships, shared by a considerable number of Oxford men at present?—As I said just now, I think that if the majority of the active resident teachers were polled at this moment, a large majority would be found in favour of a considerable reduction of the number of non-resident fellowships; but I do not think that there would be found even a respectable minority who would support the entire abolition of prize fellowships. I find very few of the senior men who would at all agree with me in thinking that the prize fellowships were not useful; they think that a certain number of prize fellowships should be bestowed every year in order to maintain classical studies, because they think that classical studies would sink without those prizes.

3822. Is it your opinion that prize fellowships are actually injurious to proficiency in classical literature?—I should rather say that the prize fellowship, as now bestowed, was injurious to the general character of study in the place. That, however, has been a debatable opinion, and to place the arguments before the Commission would require a very long account of the way in which the University got into its present mode of bestowing its fellowships; but I entered into that in print, about two years ago, so fully that I think I had better not repeat it.

3823. What is your opinion as to professors being employed as examiners?—I think it is a great defect in our system of examinations at present, that they are conducted chiefly by young tutors who examine their own pupils. There are two drawbacks in the system. First, that the tutor examiner is not thoroughly acquainted with the specialty of any given subject, but is rather a man of general information over the general field of classics; and, secondly, that he has to examine his own pupils, or persons with whom he has more or less come into contact as a teacher. That of course would be the case where the professor examined; the professor would examine pupils who had been in his classes, but an eminent professor who lectures is not expected to come into personal contact with the pupils, he hands that over, in the scheme that I have sketched, to the younger *répétiteur* who trains the pupil immediately, and that danger of being called upon to examine your own pupils would not apply, I think, to a professor.

3824. You do not, I presume, see any objection to the professors themselves being examiners?—Where a professor has made himself personally acquainted with his class, and got interested in the young men of whom it is composed, there would be the same danger as in the case of a tutor examining, but the professor would have the other advantage, which the tutor examiner has not, of being more specially acquainted with his subject.

3825. Where could the University obtain examiners if it did not employ the tutors in that capacity?—In the scheme of which I have given an outline, it would not be required that all of my second and third grade of teachers, my sub-professors, and professors, should

be employed locally in the University. It should be enough if a man showed that he was employed in any great national or public institution as a teacher, and he might, in that case, I think, carry his stipend away with him, to a place which would be in fact a place that was preparing pupils for the University. That is a privilege which would require to be strictly guarded, but, I think, in order to bring the endowments of Oxford to bear upon the face of the country at large, it would be necessary to have such an extension of the professoriate. That large body would supply a number of men, who, I think, would furnish a sufficient body of examiners over the whole field of subjects. With reference to what I was saying just now, as to the moot point, whether a professor, or a sub-professor, drawing a salary from those college endowments, should be required to be located within the precincts of the University, and to be exercising his functions there, I think, under given circumstances, he should; but I think that a certain number of those teachers might be allowed to exercise their functions over the face of England, provided the institutions where they were functioning, were up to the academic grade, and were not merely elementary schools. The rival proposal to that, is a proposal which has found a considerable degree of favour under the name affiliation, that is to say, that there should be certain schools, and colleges, and institutions, up and down the country, which should be affiliated, and that residence, and attending courses of lectures in those affiliated colleges, should be equivalent to residence in the University. I dare say that might work, but, on the whole, I would rather send the Oxford professor to the institution than bring up the candidate merely to be examined by the Oxford professor. I should be in favour of sending out colonies of teachers who might be employed in those institutions, rather than of adopting the plan of affiliating them. My first principle is, that the doors of the University should be open without bar or hindrance to all the world, not only to the English Empire, but to anyone who chose to matriculate. The affiliated system, on the contrary, limits those benefits, or gives higher privileges to the affiliated institutions, whereas I would allow anyone who chose to matriculate. Then comes the question, whether you would allow any candidate, without residence in the University, to offer himself to pass the University examination, and that is a very difficult question, certainly. I think, on the whole, that it would conduce to the general purpose of bringing the University into contact with all parts of the empire, if students from every corner of it were admitted to the examinations without residence, without passing a certain number of months or terms within the precincts, and attending certain lectures. But that would require, of course, to be carefully guarded, for this reason, that that system, which is the system of the London University, implies that an examination test, without the college test, can test everything—and it certainly cannot. The examination test can test a great deal, but there are things which the college test, or the test of residence and personal communication can test, which the examination test cannot; and, therefore, I should greatly prefer that a student should reside. Every encouragement should be given, in the way of exhibitions, to bring the students to the place, and to the professors; but as that cannot be carried through, I would, under certain safeguards, admit to the examinations of the University non-resident students, on the same system as the London University does.

3826-7. Has the subject of admitting non-resident candidates for degrees been mooted at Oxford?—It has been mooted and the question of the affiliation of colleges has been stirred, as the other alternative, but it is scarcely practical at present, because we have not got the professors, or the teachers, or the examiners.

3828. (*Dr. Sharpey.*) Do I rightly understand that while you would permit a student entering the University to go on in science, without giving evidence of

Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.



Rev.  
M. Pattison,  
B.D.  
15 Nov. 1870.

previous training in classics, nevertheless you contemplate that that might be expected from the schools previously to his entering the University?—Yes. That system was suggested to me by the German practice. The examination which is preliminary to entrance to the University is not conducted by the universities, but by a separate board, the *Abiturienten-Examen*.

3829. And would you contemplate that a student should come up to the University with such a testimony from the school of his previous education before admission to the University?—No, I do not contemplate that, for this reason, that it would be doing the very thing that I wish to avoid, and which would be excluding certain students from the University.

3830. Do you think, looking to the development of scientific study, that a person might go through that career as a man of science, advantageously, without any previous training in classical learning?—The question of the educational influences of the classics upon science, was one so large, that I did not venture to include it in my notes, but as a mere expression of opinion, I have arrived at the conclusion that an amount of culture which is practically all that a man need desire for an English career, may be obtained from science without literature, at least as well as from literature without science.

3831. Would you approve of substituting some of the modern languages for the ancient languages in the early training of men intending to go through a scientific career?—That is a very much debated point. We have no example of a purely modern training in language. Experience, I think, enables one to speak pretty well of the effect of what training in language, when it combines classics with modern languages, is; but we have so little experience, or none at all of what might be made of a training in modern languages, English, French, and German alone, without any classical foundation or accompaniment, that, I think, I could hardly see my way to give an opinion upon that point.

3832. With reference to the application of the emoluments to be derived from the suppression of superfluous fellowships, does it enter into your view that they should in any considerable degree be devoted to encourage men to reside at the University, who are engaged in original scientific research, and with a view of promoting and encouraging that research?—My third grade of the professoriate, the professors, contemplates distinctly that object as its principal object. The teaching functions of the professors should be as light as possible in order to set them free for original research.

3833. You have spoken, I think, with some hesitation as to how the question might be answered if the case in which two or more professors might be appointed to teach the same subject, and you thought it quite fitting that where the subject was divisible into different branches, such as in the case of chemistry, or of physiology, that would be a suitable arrangement, but with reference to the appointment of professors of what might be called the same subject, you rather contemplated, did you not, a junior and a senior professor, or a sub-professor and a full professor?—A senior professor with any such number of juniors as might be expedient at the moment, for I would not create for those sub-professors, or professors of the second grade, any definite number of chairs, but I would from time to time give 300*l.* or 400*l.* a year to any promising young student in any department in which his services might be required at the moment.

3834. He would be somewhat in the position of a professor *extraordinarius* in a German University, only that those extraordinary professors are quite independent of the ordinary professors, and their courses of instruction count for degrees, the same as those of the ordinary professors?—Yes, and I would have my sub-professor entirely independent of the professor.

3835. (*Marquis of Lansdowne.*) In the event of such a graduated professoriate being adopted, would you suggest the existence of any central regulative power which would decide the relation to each other

of those sub-professors and tutors, or would the professors be, as it were, autonomous?—There is an institution already existing at Cambridge and Oxford called the Board of Studies, and this board would consist of the principal professors in each branch, and in that way the professor, though not individually so, would be, as a member of the board, supreme over the arrangements in his own branch.

3836. Would the existing Board of Studies, in the event of its attaining greater proportions than those which now exist, be qualified to regulate the arrangement of studies of which, perhaps, its members might not personally be cognisant?—If this new science side is erected co-ordinately with the classical side, there would, of course, be requisite a separate independent board of scientific studies.

3837. Would you enumerate roughly the principles upon which you would contemplate science being studied by undergraduates at Oxford; would you limit it to the general culture, or do you contemplate their studying with a view to professions in after life as well?—Looking to the mass of students that we now have, it would necessarily be with a view to professions in after life.

3838. If the cultivation of science, not only at Oxford, but throughout the country, were to extend much further than it does now, would it not be necessary that there should be, somewhere or other, a sort of head-quarters, from which teachers would issue forth properly trained and properly certificated, and might not Oxford take that place hereafter?—That is the work which I should be ambitious that it should do.

3839. Supposing the bifurcation which you have described to be difficult, or impossible, would not the study of science be much facilitated by some alteration in the date of the earlier examinations. For instance, supposing a man wished to take up science, would he not be a great gainer by being allowed to pass moderations at an earlier date than he is now allowed to do so?—The proposal is under consideration at this moment, and I think I may say that it is universally accepted, of putting back moderations, either to the third or the fourth term.

3840. (*Sir J. P. Kay-Shuttleworth.*) The general tendency of your suggestions has been to give the University more power over the application of the collegiate endowments, over the teaching force of the University, over, likewise, the creation of professorships, and the definition of the curricula of study, as well as over the examination for degrees of honour. I conceive that involves an alteration in the constitution of the governing body of the University, and the Commission would be glad to know what alteration you conceive would be desirable?—The new direction which I propose to give to the college endowments, that is to say, allowing the prize fellowships gradually to merge into life professorships in three grades, could not be carried into effect by the University; the process could only be completed by the same power that began it, viz., a Parliamentary Commission. What has been done in that direction was done in 1854 by the Parliamentary Commission, and I should propose that similar powers should be created in order to carry the process still further with respect to supplementing the college authorities by the University authorities in the curriculum of study; the antithesis between the College and the University is rather one of name than of reality, for the process of which, I think, I have spoken, and which is now going on, by which the smaller colleges are combining for their lectures, raises, for the time being, the tutor from an independent teacher into a University teacher, to a certain extent. It is true that the great colleges, Christ Church, Exeter, New College, and Balliol, have not come into this scheme. They are sufficiently provided with instruction of their own, and their funds enable them to provide instructors of their own in every branch that may be required, and they have not come into this scheme, and, consequently, this inter-community of teaching only exists between a number of the smaller colleges; but



all that I propose is, that that process should be extended throughout the colleges.

3841. What I conceive would be the tendency of your suggestions would be, that the federation of colleges which exists within limited spheres should come to be a University federation; or should be the result of the operation of some governing power?—Whether that object could be effected by the powers which the University possesses at present, I do not know, but, any rate, it would certainly be a very long time before it was effected. There is a very strong college feeling on the part of the greater colleges, so that they would, no doubt, fight for their independence.

3842. Looking to the ultimate result which you contemplate, am I right in conceiving that the definition of the function of the colleges relatively to the function of the University would have to undergo a very considerable change?—It is undergoing at this moment, and has undergone in the last 10 years, a very considerable modification, all in one direction, namely, that of bringing the college officer more and more into the position of a general officer, and all that I propose is, that that process should be expedited with as much speed as may be found to be practicable.

3843. There would remain, then, for each college the regulation of discipline as respects character, manners, and probably preparatory studies, whilst to the University would remain the larger functions which I described in my first question?—Precisely so.

3844. And that process which is now going on slowly, and somewhat imperfectly, by the powers which exist in the University, you would expect would go on more rapidly, and in a more regular form, if something like the power of the University Commission were again applied to that object?—Not only would it be impossible, without parliamentary power, to touch the endowments which are the separate property of so many distinct corporations, but it would be impossible to fully effect the other objects which I have enumerated without an interference from without.

3845. What I understand is, that there exists in the University itself, in a growing degree, the spirit of this change which is operating within the University, but that you conceive that to give to that spirit, and to the individuals the force which is requisite for the entire change, it is desirable that Parliament should interfere, and that a Commission should be appointed for that purpose?—Supposing that Parliament decided to interfere with us, I think it would be for the purpose of dealing with the endowments. How far it would be expedient that the same Parliamentary Commission, which would necessarily have to be created in order to deal with the endowments in the way that I propose, should also deal with the internal regulations, as to the examinations and the studies, I think might be doubtful. If the endowments were once applied in anything like the way in which I propose, which is merely in the same way in which they were begun to be applied in the year 1854, I think the rest would probably follow.

3846. I understand you to say that, *ceteris paribus*, you consider scientific culture to afford as sufficient a means of education as classical culture, and that you would remove every impediment out of the student's way in entering the University for the scientific course without any preliminary examination?—I should be sorry to think that the principle which I have said I assume as a fundamental one, namely, that the doors of the University should be opened without bar or hindrance to any one that presented himself, and wished to matriculate, was supposed to rest on a speculative theory as to the value of different kinds of education. Whether or no a scientific education be as good an education as a literary education, I would still have the curriculum, which I have proposed, of pure science. I do not think it follows, in any way, that because one method of education is abstractedly the best, therefore it should be the only one that the University offers.

3847. My question had reference to the entrance of the student into the University, and as to whether any degree of culture of any kind should be required upon

his entrance into the University?—My scheme proceeds upon this hypothesis, that the University shall not inquire what the student brings. If you choose to come and pay your entrance fee, and attend our lectures, and comply with our regulations, you may come; you need not pass a single examination or take a degree; you may come and live there and attend the lectures and get what good you can. I would not exclude anyone from anything, but if a man wanted a degree, I should say to him, "We shall require you at the end of your first year to pass my preliminary examination, and at the end of your third year to pass my final examination, but you may enter the University and get what good you can from it, such as you are; we shall not inquire what you are."

3848. Your replies exactly bring out what I desire to understand, that there has been no pre-judgment expressed by you as to the nature of the previous culture which you consider to be desirable?—I am ready to offer to the Commissioners an opinion, whatever it is worth, as to the value of scientific study; but I do not wish that my scheme of the University should be considered to rest upon an opinion, which, after all, is only an opinion upon a speculative point.

3849. There would be this obvious advantage, in opening the studies at the University to all persons, whatever their previous culture was, up to the first examination, that self-educated men, who have not had the advantages of any public or private schools, could present themselves and take advantage of the studies in the university?—Certainly; and it is that large class of most valuable students whom I think the matriculation examination tends to exclude without any adequate benefit to the University.

3850. And probably your own observations have furnished you with abundant proofs of the fact, which transpires in all walks of life in which science is applied to the arts, that there are men of great natural talent who would avail themselves of such opportunities if they were offered by the University?—Yes; I see that they do so in the London University. A large proportion of the candidates for the first B.A. enter themselves as "private study," and many of those men are schoolmasters in a very humble way, who, along with teaching what they do teach, have managed to prepare themselves for the B.A. examination.

3851. There would be, therefore, two forms of freedom,—the freedom of the previous course of preparation, and the freedom up to the point of the end of the first year's study, when the first examination was imposed?—Yes.

3852. (*Professor Huxley.*) Do not you think that it may be part of the business of a University, as distinguished from other teaching bodies, to set up a standard or model of culture?—That is rather an abstract question. When you say a University, I think it possible that such a function might be very usefully performed by a University, but here is a University which is in possession of the largest endowment existing in the world for knowledge purposes, and this endowment is the property of the people of England, and I think that every step we take ought to be in the direction of opening the doors, and not of shutting them. Now, if you set up an institution, which by its examinations exacts a definite line of culture (and the highest culture, whatever it is, must be a very definite line of culture), it must necessarily tend in the direction of exclusiveness. I should not like the University to erect such a standard, unless it was the very highest standard, and I cannot see how that could be done without going very far in the direction of excluding many of those who ought to share in its benefits.

3853. Do not you think that permitting the principle of bifurcation from the beginning might rather tend to lower the character of the University, and to take it away from that ideal university which we both have in our minds, and to convert it into what would not be very much better than a technical college, giving a degree for special proficiency, either in literature or

Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.



Rev.  
M. Pattison,  
B.D.

15 Nov. 1870.

the one hand, or in science on the other?—That question raises the very difficult question of the degree in which the specialisation of science can be an instrument of mental development. It seems to me (but this is only an opinion which is derived from books and reading history and biography, and seeing what great men have lived and what one knows of the antecedents of great men) that all real culture must be founded upon specialisation; that the system of general information, knowing a little of the surface of half a dozen things, has its value, but that on the whole, the result of such an education is an inferior result to the result of a deep and thorough investigation of some one great branch of knowledge.

3854. But looking upon what we may call cultivated people, even as they are at present, is it not the case, that the entire want of power of sympathy between the literary class as a whole and the scientific class, and, on the other hand, between the scientific class as a whole, and the literary class which specially exists in England, is a very great evil?—No doubt it is a very great evil.

3855. Might not that evil be corrected to some considerable extent, if all persons who aspired to have the mark set upon them of possessing the higher culture, were obliged in the course of their training to pass through some common discipline, surely not of a superficial kind, but though a limited, yet a genuine kind, so that a man of science, when he subsequently specialised himself should still have had a sufficiently sound literary training to make him understand what literature is; and, on the other hand, that a man of letters should have a limited but a sufficiently sound acquaintance with science to make him understand what science is—would not that be a better state of things than to allow the two classes to branch off in ignorance of each other altogether?—I see very strongly the evil of which you speak, because it is an evil which is much more developed in Germany than it is in this country, and it is very much to be lamented; but I do not feel quite sure that that separation between the literary and the scientific class is caused by the depth and thoroughness of the studies of either of the two classes. I think that true thoroughness in a scientific man, and true thoroughness in a philological man would not tend to isolate him from other branches, but, on the other hand, he would, as they say, come out on the other side. If you have got past a certain stratum in investigation, your sympathies begin to widen, and the more you know of your subject the more you begin to see that it has its ramifications into every other subject.

3856. No doubt that remark must apply completely and admirably to the higher classes of persons in each department, but a university must look to giving a training to the average man as well as to the higher man, and surely, for the average man, it is better to have had such an acquaintance in early life with that sort of general knowledge which would be and might be given by requiring him to have gone through a certain amount both of literature and science at starting?—That is the vexed question of education. A very large school of practical men has pronounced most emphatically on the side of general literary culture; and more than that, we can see the system exemplified in France—that is the type of French education through all its grades—a little of everything and nothing thoroughly. I do not suppose that any of those who have been led by their experience to adopt that conclusion would be likely to be converted to the other side, but I have not been led to that conclusion. I think that French education has its merits, but that they are very greatly inferior to those of the German system.

3857. May I say that what I am contemplating now is by no means giving a little knowledge of a good many things without a good knowledge of any; that, I have no doubt, is a very proper description of the French system, and no condemnation would be more hearty than my own of any system of training of that kind; but surely it must be possible, by limiting the attention of the student in each direction, to give him a

thorough training in literature; making it thorough and real as far as it goes; and you surely can, by limiting the training in science, make it thorough as far as it goes. I am myself disposed to think that the attempt has never been seriously made, and made with proper judgment, to give a training which should be thorough, and at the same time limited; but if it could be made, if without attempting to give him a knowledge of everything, a man were well disciplined in literature and in languages, and his training in science were restricted to the two or three branches, at the outside, which are most essential, do not you think that a great advantage might result from such a course?—Then I must divide men into the average man and the best man. With respect to the average man, that experiment seems to me to be very fairly tried by the London University, now that a second B.A. must pass necessarily in Greek, in Latin, in Greek history, in mathematics, in physiology, in logic, and a failure in any one of those subjects is fatal to him. This is the average man, and I do not think, on the whole, that the results of that attempt are very successful, though I admit that, as the attempt had never been made in this country before, a very great deal has been effected by the London University degree in that way, and it has been highly beneficial to the schools, such as they were. But now we are speaking, not of what might be done at the moment with the schools as they are, but of what should be aimed to be done, and, in that respect, I think that we can aim practically at a better degree than that which is now given by the composite degree of the London University.

3858. Are you quite satisfied that the scientific education given to a B.A. candidate in the University of London is in any way comparable to the sort of sound scientific training that I am referring to?—There you rather imply that I am wrong in thinking that the London University is an actual instance of that which you propose, or I must have misunderstood what you proposed to aim at.

3859. I understood your reply just now, when I asked you as to whether the University should endeavour to set up a standard of culture or not, that it referred rather to the existing state of things than to what you would be inclined to do yourself if you had a *tabula rasa*, and were creating a university of your own, but supposing those practical difficulties did not exist, would you still be of opinion that it would be well for the University to begin with some common ground of knowledge and discipline required of everybody?—If I understand the question aright, it seems to involve this—What is the value of mere literary culture taken by itself?

3860. What I meant to say is, whether, if you could have an ideal university, it would not be better that the persons who obtained the degrees of that university should possess both scientific and literary culture than that they should possess only one?—I should doubt that sufficient thoroughness can be got out of literary culture purely and simply to give the highest tone to the mind. Without the scientific idea, without having gone through for yourself some one subject by the guidance of the scientific idea belonging to that subject, I think you lose that one element which is the foundation of all true mental structure.

3861. And would it be true conversely, that a thorough acquaintance with the scientific idea would still leave a man very imperfect, looked upon as a cultured person, unless he had become acquainted with the modes of expression and with the historical methods of thought which are more appropriately obtained by literary culture?—Then I must divide the subjects which are usually classed as literature into their parts. You may have history, or you may have logic and philosophy, or you may have the remains of ancient literature, or you may have any one of those three things, and, no doubt, a man who founded himself upon a thorough scientific investigation of something, and added to that an acquaintance with one of those three things, would be a larger minded man than a man who had the scientific knowledge without one of those three things;



but, looking at human life, and human power, and the occupations of mankind, I doubt whether a man could add to his scientific knowledge more than one of those three things in such a measure as to affect the real bearings and original force of his mind. He might add a certain amount of elegant accomplishment by a general acquaintance with history and with literature, say, over and above an acquaintance with logic and philosophy, but to do any one of those three things thoroughly requires many years of devotion.

3862. (*Mr. Samuelson.*) You stated, did you not, that in order that the incomes of fellowships might be diverted to the purposes of teaching, statutory powers, which could only be supplied by Parliament, would be necessary?—Certainly.

3863. Is that because the colleges under their statutes have not the power to effect a change of the kind, or because they would not be willing to effect it?—It is because they would not be willing to effect the change.

3864. So that, in the measure in which they would be inclined to effect a change of that kind, they would have power to do so independently of the Legislature?—Under the Ordinance of 1854 nearly every college, with the consent of its Visitor if necessary, and, in some cases, of a majority of two-thirds, has the power of remodelling its constitution, but though there may be in every college a minority which would wish to devote a part of the college funds to science, I doubt if in any college, at this moment, there would be a majority in favour of actually using the power which they possess, in conjunction with the Visitor, of altering the direction of their endowments in such a way as to devote a large portion of them to the purposes of scientific culture.

3865. So that, in point of fact, such a change as you suggest would have to be effected in opposition to the feeling of the majority of the governing bodies of the existing colleges?—It would have to be effected in the same way as the change of 1854 was effected, by being strongly backed up by a minority, who made up in their influence and energy for what they wanted in number.

3866. Without any diversion of the college funds from the purposes to which they are now applied, is it not the case, that in many colleges, if not in most, there is an increase of property going on which those colleges might devote to purposes of instruction in science, if they were so inclined?—In order to answer that question, I ought to know how far the provisions under the ordinances of 1854 have in each college proceeded; that is a matter of detail which I do not know, but I apprehend that there is not at present in any college a large sum that is available for purposes of scientific instruction.

3867. Would you be prepared to state what is the position of your own college in that respect?—The resources of my own college are so very small, that they are scarcely worth speaking of when we are dealing with such large sums as are in the possession of the greater colleges. There are Colleges the income of which approaches 20,000*l.*, 30,000*l.*, and 40,000*l.* a year, whereas the total income of my college is about 6,000*l.* a year.

3868. And it is not one which is increasing so rapidly as to afford any hope of your being able to afford any large support to science within a reasonable time, in addition to the objects to which you now apply your funds?—There is no surplus fund in our college, over and above what is already appropriated, that could be devoted to scientific purposes. The classical learning and classical studies of every kind are sufficiently provided for in the other colleges, and, as a classical school, we are contending at very great disadvantage in offering those large premiums of 80*l.* and 100*l.* a year to students, and yet we cannot get them, because the rich colleges carry off all the best men.

3869. Within certain limits the attraction of the large colleges also affects, does it not, the scheme of unattached students?—That is an experiment, but at present unattached students come from a class who

are so poor that it is an object with them not to live in college, for it is now quite ascertained that a man can live out of college very much more cheaply than he can in, and, consequently, unless one of those unattached students is up to the work of getting a scholarship, he will not live in any college. It does not come to him as a question, "What college shall I prefer?" but it comes to him, "Do I prefer living out, to living in any college?"

3870. But for unattached students there are scarcely any scholarships, they are really University students, are they not?—An unattached student can stand at any college and get a scholarship if he can.

3871. He would then have to reside in a college, would he not?—Yes, he would have to begin residence, but, seeing that he would get 80*l.* a year to meet the expense, he would think himself improved in circumstances.

3872. Even in spite of the large amount of the scholarship that he might receive, he would still find it very expensive?—Yes.

3873. But, in any re-distribution of college revenues, in the shape of scholarships, such as you contemplate, I presume you would not confine them to colleges, but you would also allow unattached students to share them?—They would share them in this way, that everything would be open to their competition, but it is so now; the reason why a man is an unattached student is, that he is not up to the mark of getting a scholarship.

3874. Do you mean, that education of a character which would enable him to obtain a scholarship is too expensive?—That is going into his antecedents; that may be the cause why he is not up to the mark, but the reason why he is not up to the mark may be simply that he could not avail himself of the education which he might have.

3875. In reference to an expression which you made use of, that matriculation should, in your opinion, be open to all the world, is it not the case that you have at Oxford, at this moment, many young men that have neither ability nor diligence sufficient to obtain a fourth?—Far the larger number of those who come out every year as Bachelors of Arts, are below the minimum of the fourth.

3876. But my question had relation, not to the actual results, but to the capacity and industry of the young men?—For some reason or other, which we cannot tell, they do not come out even in a fourth.

3877. Do you think that the presence of such young men is desirable for the University?—No doubt the presence of the wealthy and idle class is one of the greatest difficulties with which we have to struggle, but I should be very unwilling to see any measure taken for keeping anybody away from the University who is willing to come, for any reason whatever.

3878. Do you think that those young men themselves, or the University are benefited by their presence?—I think that, considering what a wealthy young Englishman is, I could not predicate about them individually, but if you take them in masses, I think that upon the whole it is better for them that they should have passed through the University than they should not.

3879. But do you think that there is not a very great disadvantage in the example which such young men afford to other students?—Very great disadvantage.

3880. If you had a matriculation examination, or something answering the same purpose as the *abiturienten-examen* of which you spoke, do you think that many of those young men would be kept out, or do you rather think that they would endeavour to qualify themselves and to acquire somewhat more studious habits?—I am afraid that, in the first instance, a third mode would be the result; the standard of the matriculation examination would be so lowered that the same would take place as with the B.A. now. Those young men get their B.A. degree. The value of the examination that they pass is below appreciation, and yet they get their B.A. degree. I think that the

*Rev.  
M. Pattison,  
B.D.*

15 Nov. 1870.



Rev.  
M. Pattison,  
B.D.  
15 Nov. 1870.

pressure of the numbers of that class upon the doors of the University would be such that the matriculation examination would very soon be adapted to let them in.

3881. Why should that be so?—For the same reason that the fact actually comes to pass at the degree examination.

3882. Do you think that the examiners would not have sufficient strength to resist the pressure which would be brought to bear upon them?—Strength would not do it. If 100 men come up and only 10 of them are competent really to derive benefit from the college lectures, you cannot pluck 90 men straight off.

3883. Do not you think it probable that if you were to pluck 90 at one examination, you would only have to pluck 60 or 70 at the next?—That is not the experience of the B.A. examinations. The usual experience of the B.A. examinations is, that if you pluck a great many you have an additional number presenting themselves next time.

3884. (*Chairman.*) I understood you to say that the colleges can appropriate fellowships as they please, to any branch of science, but can they suppress fellowships,

and apply the funds to the purposes of the University even with their own consent?—Yes, they can do that.

3885. Therefore, they do not require parliamentary powers to apply any of their funds to general university purposes?—No, they do not.

3886. Could that proposal which you threw out for substituting University scholarships for college scholarships be carried into effect with the consent of the colleges?—I believe that the clause in the college ordinances which gives them enabling powers, is pretty nearly worded the same in all the ordinances. I am not quite sure upon that point, there may be a little difference, but, generally speaking, the clause in most of the statutes would enable them to do that.

3887. Did I rightly understand you, also, to say, that the college tutorial system was gradually decaying?—That it was gradually being superseded by a combined system of tuition, the effect of which combination is to raise the college tutor for the time being over a given area into a University officer, inasmuch as he no longer lectures to the pupils of his own college, but to the pupils of a variety of colleges taken promiscuously.

3888. That applies, I presume, to the smaller colleges?—Yes.

The witness withdrew.

Adjourned to to-morrow at 11 o'clock.

No. 6, Old Palace Yard, Westminster, Wednesday, 16th November 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.,  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

The Rev. BENJAMIN JOWETT, M.A., examined.

Rev.  
B. Jowett,  
M.A.  
16 Nov. 1870.

3889. (*Chairman.*) I believe you are Master of Balliol College, and also Professor of Greek in the University of Oxford?—Yes.

3890. The Commission would be glad to learn your opinion as to any measures which you could recommend to be taken in the colleges for the promotion of science?—I wish to state, before I begin, that I have not much to say to the Commission. I came here because I was requested, and the opinions that I may give are not based upon any knowledge of science, to which I do not pretend. With respect to the question which has been asked me, I think we must distinguish between the colleges and the university. The single colleges cannot do much. I should like to explain, whilst upon that subject, that a considerable change has taken place in the mode of education in the university in the last 20 years. In the last century the colleges did well enough; they were a kind of boarding houses, and the persons who studied there studied for themselves, almost without teachers. Then, at the commencement of this century, we began our system of honours, and the colleges provided a certain amount of teaching. But when the change was made to a system of honours, about 15 years ago, which admitted new subjects of study, the teaching given was altogether insufficient, and the want has led to a change: first of all to a revival of the professorial system of university teaching, which 30 years ago was almost nothing; and secondly, to what has been perhaps the more practical feature of the change, the combination of different colleges for the teaching of different subjects. Our colleges at Oxford are small; there is only one of them, which contains more than 200 students, and not more than four or five of them contain more than 100. Hence it is impossible to supply instruction in many different branches of study without some kind of combination, and this has led to the combination of

colleges of which I speak. I am explaining why single colleges can do comparatively little. What they can do, I think, amounts to this—first of all, they can provide good elementary mathematical instruction, and they can probably furnish some simple kind of apparatus for instruction in science and art. But the greater part must be done by a division of labour, one college taking one subject and another college taking another. There is, however, another way in which the colleges may promote science, namely, by the use of some part of their revenues; for the revenues of the colleges amount to three or four times the revenue of the university. While admitting that these revenues are national property, to be used for the purposes of the higher education, I should maintain that there must be some proportion between the supply and the demand, and that it would be ridiculous to ask that a large portion of the university or college endowments should be set apart for physical science until you had students who were likely to need them—you must first create or draw the students, and then you may assign scholarships and fellowships to them. Two matters of detail may be briefly noticed. At present there are certain fellowships set apart for physical science at different colleges, and there are also scholarships; but I think a great part of the effect of them as a stimulus is lost by the want of regularity in filling them up. If an arrangement were made between the colleges by which the fellowships followed one another in regular order, so that the student of physics might be sure that in the whole university one or two would fall vacant every year, they would be much more useful than they are at present. Secondly, I think that there should be a much greater proportion of scholarships, compared with fellowships. It appears to me much more important to make a number of students than to



reward a few, because what you want is to increase the supply of students.

3891. The number of scholarships allotted to physical science at present is very small, is it not?—It is very small compared with the number of scholarships allotted to other things, but not very small compared with the number of students in physical science. I do not think that there is any instance of a person remaining at Oxford for three or four years without a scholarship or without a fellowship who was distinguished either in physics or mathematics.

3892. Has your college taken any measures for the promotion of scientific instruction?—Some years ago we had a laboratory at the college, and we made a beginning of teaching in physical science, but those things can be done so much better on a larger scale, that we have given up the laboratory, and the students who pursue physical science go to the new museum.

3893. At present each college acts independently of every other college, does it not, in recognising physical science either in fellowships or scholarships?—I believe so; at least this is the case in most colleges. If they could have a student eminent in physical science they would sooner take him than a classical student who was inferior to him, but they would object, and I think rightly, to having an inferior man forced upon them merely because he was a student of physical science.

3894. At present, I presume, there is not a large number of students of sufficient attainments in physical science to deserve scholarships?—No. A few more might be drawn by a greater number of scholarships, but at present the number is not large.

3895. Has the number been increasing since scholarships have been awarded to physical science?—There are more students of physical science than there were 20 years ago, and this is due in some degree to the scholarships, but also to the teaching at the museum and the laboratories. There are not more students, I think, than there were five or six years ago.

3896. The university has also made very large provision, has it not, for teaching physical science?—I am no judge, but I should think that nothing could be better than the provisions made by the university in the way of buildings and apparatus.

3897. Do you think that any further measures for the promotion of physical science are desirable so far as the university itself is concerned?—Yes; I think many things might be done in the university to encourage physical science. At present physical science, as a branch of study, has not been popular or successful in the university, judging by the number of students. We have many excellent professors and first rate apparatus, but still the number of persons who go in for honours in physical science, does not seem to increase. The number of those who take honours is very small, indeed, not a fourth part of those who take honours in law and modern history—on the average of the last 10 years not more than 10 a year; among the passmen the disproportion is still greater, and appears to be increasing; during the last five years, there have not been more than three or four in the year. There are hardly any passmen in physical science. Perhaps we may consider the causes of that a little. One cause of it is that the change in the system has not been going on very long; it is only within the last 12 or 15 years that we have begun to study these things at all. When I was an undergraduate, about 30 or 32 years ago, in what Lord Derby called the pre-scientific age, nobody at Oxford either learnt or had the means of learning such subjects. So that we must not be too much disappointed at present results, because the system has been going on as yet only for a short time. But at the same time, if I compare the two new subjects of instruction which were introduced into Oxford 15 years ago, the one being law and modern history, and the other physical science, they stood upon much about the same footing, as far as the stimulus of endowments went, and no doubt physical science has had by far the advantage in point of teachers, but the

result has been what I have described, namely, that the candidates for honours in the School of Physical Science have not been one fourth of those in the school of modern history, and the passmen of late years not one in ten or twenty, although the two schools seemed to have a fair field and to be on equal terms. There is another point which I should notice. It has been pithily said about physical science that at Oxford everybody is bribed to learn something else. That was true perhaps 20 or 30 years ago, but is not true now, and it certainly does not apply to the Scotch or German universities, where the same thing equally holds that literature is the attractive and the stronger element, and not science. That brings me to consider in what way the interests of physical science in the university can really be promoted. I am inclined to think that physical science can only be spread in one way, and that is by connecting it with the professions. There are two professions with which you would naturally connect it, the medical profession and the profession of an engineer, and if you want to increase the number of physical science students and to arouse the spirit of physical science in the university, you must draw from those two classes of students of medicine and engineering. That leads me to the question how far you would alter the university system in order to admit them, or to admit them on easier terms. I may say at once that I am not for giving up any element of university instruction that at present exists, and I believe that the object may be attained without this. The suggestions which I would offer about it would be something of this kind. I think that we might have a temporary class of students who would be admitted to the honours of the university and to the scholarships, and who would receive a free education (that is to say, the lectures in physical science might be open to them), but who would not take a degree. There I should be disposed to draw the line. I would not let any person take a degree who had not fulfilled the present requirements of the university. Then I think I would make a further relaxation in this way. I would not insist upon those requirements being complied with at any particular time; say, for instance, that a person came up to the university knowing nothing of Latin or Greek, before he could take his degree he should be required to know them; but I would not debar him from studying in the university, or taking honours in his own subjects, or from sharing in some of the emoluments of the university. There are one or two other things which might be done for physical science. It may very fairly be retorted on this plan which I have just suggested, "then you require literature as a condition of taking a degree, but you do not require science." I should be inclined to require from everyone a certain amount of science before he took his degree. I should put the different individuals on the same footing in that respect. There is a question now very much mooted, with regard to Greek, which I will remark upon by-and-by. Without introducing this I will say generally that every one who takes a university degree should be required to have some literary as well as scientific training. I think in that way there would be a very great stimulus given to physical science. The only thing that a student of physical science would be held back from would be the degree, and upon that I would like to say a few words. Some persons have schemes for giving degrees in science alone, and for giving a medical degree without those literary requirements that I speak of, as is done at other universities; but an Oxford degree, whether rightly or wrongly, is thought to have a value that the degrees of those other universities have not, and if you took away the literary part, I imagine that you would take away that value from the degree. I think if you gave the Oxford degree for something else than what the Oxford degree is given for now, not adding something to what you require at present, but taking away something, that is taking away the literary part of it, you would find that it had lost what may be called its social value. In short, to

Rev.  
B. Jowett,  
M.A.

16 Nov. 1870.



Rev.  
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M.A.  
16 Nov. 1870.

sum up what I have been saying, I should look for the great improvement and extension of physical science in the universities from professional students, and I should propose to admit them to honours, to free lectures, and to scholarships, and to allow them to pass their literary examination at any time they pleased, and, of course, to become members of colleges.

3898. You mean that you would allow them to obtain degrees if they passed a literary examination?—Yes; but I would allow them to pass it at any period of their course.

3899. (*Mr. Samuelson.*) Do you mean that they could be members of colleges without taking the degree of B.A.?—I mean that they might be members of colleges, and scholars if they obtained a scholarship, but not fellows. I would not require them to take a degree as a condition of obtaining a fellowship, but to pass all the examinations which are required for the obtaining of a degree.

3900. (*Chairman.*) You would allow them to take advantage of the lectures without any literary test whatever?—Yes, and I would allow them to obtain scientific distinctions at the university.

3901. (*Dr. Sharpey.*) Without a preliminary examination on entering the university?—Yes.

3902. And without necessarily taking a scholarship?—Yes.

3903. (*Chairman.*) Did I rightly understand from you that any student who applied himself to physical science and attained proficiency in physical science would be almost certain of obtaining a fellowship at present?—Yes, one who was distinguished in physical science, would, I think, obtain a fellowship or scholarship.

3904. Do you think that, to the greater part of young men, there is anything more attractive in literature, than in the study of science?—I am inclined to think that in general it is more attractive. There are a few persons, or perhaps a good many, who could be cultivated by physical science, and who could not be cultivated in any other way.

3905. From what you have seen of young men, you think that the greater number would devote themselves to literature rather than to science?—Yes, and I would appeal to the fact that I mentioned just now of the two schools at Oxford, the comparative success of the modern history school, although under some peculiar disadvantages compared with the physical science school.

3906. Do you think that any part of that tendency arises from old traditions?—It is impossible to separate that element.

3907. (*Sir J. P. Kay-Shuttleworth.*) And from the previous training in existing endowed and public schools?—Yes; but that appears to me to be an uncertain quantity. The teaching of history or of general knowledge in schools is also of very recent growth, though not quite so recent as physical science. I wish to see them put upon a level, and to have a fair field, but without giving up any requirements which at present exist either in colleges or in the higher schools. Which will conquer as the main element of education is, I think, rather a matter of speculation.

3908. (*Chairman.*) You think that no degree should be granted without a certain amount of scientific attainment?—I think not.

3909. When would you require that minimum to be tested?—I should apply the same principle to all the different subjects that they might be tested at any time during the student's course, but that before he could have his degree he must go through this test.

3910. At present is not this the system at Oxford, that every student must pass moderations at the end of the first year?—Yes, or rather at the end of the first year and a half.

3911. And that is chiefly classical, is it not?—There are two schools, the one classical and the other mathematical.

3912. May a student pass in classics without any mathematics at moderations?—He may at moderations,

but not at responsions; every undergraduate is required to know some Euclid and arithmetic.

3913. No young man at Oxford at present can obtain a degree without some mathematics?—No; not without arithmetic and two books of Euclid, or a corresponding amount of algebra.

3914. Would you add to the mathematics and also put in a certain amount of science in addition?—I would.

3915. But you would allow him to pass the examination required for that purpose at any period of the university career?—Yes.

3916. Leaving the final schools as they are now?—I think we pretty nearly cover the whole field in the final schools. There are examinations not only in classics and theology, but in mathematics, physical science, and modern history. In moderations I would have additional examinations in physical science and modern history; for if it is a good thing to stimulate men and make them industrious in classics in the early part of their career, the same principle applies to other subjects. If a man were allowed to pass an examination in honours immediately or soon after he came up, this would have the effect of drawing a great many men to the university who would come for that distinct purpose, and leave again after passing the examination. That would combine the view which makes an university a place of examinations merely with the other view, with which in the main I agree, which requires also residence; and a useful link of connexion would be supplied between the universities and the schools which aim at giving a general rather than a classical education.

3917. Will you now be good enough to express your opinion upon the advisability of omitting Greek?—I think that runs up into a more general question. Greek is a subject which excites attention at this moment, but there is a more general question behind that, whether you would separate literary from scientific culture, about which I will say a few words first of all, and then go on to the subject of Greek. I would repeat what I said just now, that I think that in endeavouring to obtain an Oxford University degree for science, whatever be the value of it, you would alter its character if you took away the literary element in it. The man of science who had a merely scientific distinction would find that he had got a different thing, whether it were a better thing or not, from what an Oxford degree is at present. But there are deeper grounds upon which the question is to be argued. I think that it would be a loss of a great element of education. The want of literature appears to me a great defect in the education of any one; the purely scientific man feels the loss in a great many ways. He cannot express himself freely; he is shut out from many human interests. He is liable to take a narrow view of his own science in relation to other sciences, and of the physical sciences generally in relation to the moral. On the other hand a person who, like myself, has no acquaintance with physics, is in another sense ignorant of the world. There are some other considerations which bear upon this subject. It appears to me that there is some tendency to confuse the greatness of those subjects of physical science, which is a well-assured matter as to which none of us can have any doubt, with their value as instruments of education. That is very great no doubt in some ways, but still it is in a great measure an unknown quantity, about which we are trying an experiment. My own impression is that experience shows that literature of some kind is more adapted to the mass of students, that literature is upon the whole for the many, and that physical science is upon the whole for the few, although I should not like either to be pursued exclusively. There is another view which is often taken of this subject. It is urged that it is so much better to learn one thing well than to learn a great many things indifferently; and put in that form, no doubt this is a view with which we should all agree, but I think that we should distinguish between preliminary education, which ought



to be general, and the education of after life, which ought to be special. If you take those physical sciences themselves (as I was saying, I only speak as an outsider), would not any physicist distinguished in any particular branch, wish that he had had some general culture in the other branches of physical science? In the same way it is also desirable that there should be some general culture in literature. Science has a great deal to do with the imagination; the scientific man is not the dry man, and there are a great many elements of poetry and literature which it is desirable to cultivate in science. I believe that you can hardly have a really scientific mind without the other kind of cultivation. There are a few exceptional geniuses in whom we may see every kind of gift almost blossom by nature, like Faraday, for instance; but I do not think that that would be the case with the mass of mankind. One tendency which may be observed in students of physical science is, that they are to a much greater extent under the power of general ideas than one would expect. It is not true that the mere investigation of facts makes a man always the best judge of them, or most cautious in raising hypotheses upon them. Take a man a very little out of his own beat, and some general idea that has a sympathy with his mind easily catches hold of him; and I think I observe this tendency among physicists as well as among divines and moral philosophers. A certain amount of metaphysics or mental philosophy seems to be required in order to get rid of the illusions of metaphysics and of language which are always latent in us. To come to the last point: about the study of Greek I feel some hesitation in speaking, because it will be thought that everybody upholds his own study; but I think that it would be a mistake to give up Greek as a requirement for a degree in the university or for the higher kinds of schools. I am far from saying that it should be taught everywhere where it is taught now, and I admit what may be said about the little that persons learn of Greek and how soon they forget it, and how it is droned out by some schoolmasters; but side by side with that, I would ask you to put the question, what may become of physical science if it gets into the same position, if it becomes traditional for 300 years, and is droned out by third-rate teachers to third-rate minds. We should probably find both studies in much the same position. We must remember that new sciences have great advantages as well as great disadvantages. They have great disadvantages in the prejudices of mankind and old traditions being against them; but they have also great advantages in having enlightened men to teach them, and in their having probably better teachers, so that we cannot judge of what they will be from what they are at present; we cannot at all judge from the lectures of Professor Huxley or Faraday what the teaching of science may be hereafter in schools. But coming back to the principal point, I am not disposed to give up Greek because it is the greatest literature in the world, and although it may only affect the few, I think you cannot give it up without seriously lowering the higher education of the country.

3918. Have you formed any opinion as to the age up to which general education can profitably be continued, the age up to which young men should combine literature and science, and mathematics?—I think that turns upon how much time you can afford to give to it; the question is one of expense. It is an advantage to a young man to continue his education almost as long as possible, say up to 22, if he can afford it. But then you have to meet the wants of people in general. I do not propose that this literary education of which I speak should be confined to any particular time. I should wish that both the literary and the scientific part should be taken at any time, according to the convenience of the pupil, but I think that up to 21 or 22 is not too long a time to spend in general education which would gradually narrow into professional. A man would not at 22 be starting on his regular studies as a medical man without some previous knowledge of chemistry and such things.

There may be some who wish to make up in later life for the deficiencies of early training, and I would give them every encouragement to do so.

3919. Am I right in supposing that at present after a young man has passed the moderations examination, he may, if he pleases, shut up his classical book altogether, and obtain a degree without any further study of classics?—Yes.

3920. Do you think it is unadvisable that there should be any compulsion to induce him to continue his classical studies to a later period?—I think so; I should go further, and take off the compulsion which exists at present. I should let him enter the university without any classical knowledge, but I would require him to get it in the course of his time there, as is the case at the Scotch universities. I should only require every one entering the university to have knowledge of some kind or other.

3921. (*Dr. Sharpey.*) You have spoken of the great advantage of an acquaintance with Greek literature, that is one thing; but another question has arisen whether a very small amount of knowledge of the Greek language is of moment in entering upon a course of education in science?—If we take these things in detail, with reference to inferior students, it is true you cannot say that there is very much good in a very small amount of knowledge of Greek, nor perhaps in a small amount of chemistry, or any other study, but I think there is some good in the habit of learning, and in the training and accuracy which is required even for the knowledge of a small amount of Greek; and I may add that not much is needed in order to enable a student to read Homer in the original.

3922. (*Professor Stokes.*) Do you not think that the qualities of mind which are exercised in the study of one dead language are so nearly the same as those which are exercised in the study of another, that those particular qualities could be exercised, we will say, by the study of Latin as well as by that of Greek?—I admit that to a certain extent; still, the question admits of being retorted. Might not one physical science do as well as two? I think that considering the greatness of the literature, and the small additional time that is generally required to add Greek to Latin, it is quite worth while to retain it. If you mean the discipline which is got by language, it is true that the learning of any one language teaches you more than the learning of a second, but the learning of a second adds something. I regard the language as inseparable from some knowledge of the literature, and the value of Greek literature seems to me far greater than that of Latin.

3923. Of course I do not dispute the value of a study of Greek abstractedly, all I meant was whether it was your opinion that this one dead language might not better be dispensed with than physical science, which is a thing totally different in its character from the study of language, although of course if you could take both languages so much the better?—I think that there is time for both. One of the doubts I have in proposing to require physical science of all persons is that the teaching of it is comparatively rare; and before you compel anything it seems to me that you must provide the means of acquiring it more than you do at present, and that I think may be set in the opposite scale against the consideration which you urge.

3924. (*Sir J. P. Kay-Shuttleworth.*) I have understood you to say that you would require some kind of scientific attainment in the ordinary degrees of the university. Have you formed for yourself any definite conception of what that scientific attainment should be, and whether it should be special relatively to any particular science, or general relatively to the sciences?—That is a question which I would rather leave scientific men to settle.

3925. I apprehend, however, that you would have no difficulty in deciding that, whether with respect to scientific or classical knowledge, it should be of an exact and positive character in the examination for a degree?—Certainly.

3926. That would rather lead, would it not, to the

*Rev.  
B. Jowett,  
M.A.*

16 Nov. 1870.



Rev.  
B. Jowett,  
M.A.  
16 Nov. 1870.

limitation of the extent of scientific acquirement if the present classical studies are to be pursued, than to its diffusion over a wide surface?—Speaking on general grounds, I should have no doubt that it ought to be rather a small and exact amount that you require of science, than a general acquaintance with science.

3927. I think I understand you to say that you propose that no degree should be given without classics, though you would open the honours and emoluments of the colleges to all?—I think I said some of the emoluments. I would open the scholarships, but not the fellowships.

3928. You would open the scholarships to the scientific students without the fellowships?—Yes; I would open the scholarships to the exclusively scientific students, but not the fellowships.

3929. Would not the result of that be that the government of the university would still remain amongst those who had obtained degrees by means of classics with a minimum of scientific acquirement?—That might continue to be the case in any event, because it would be a question of numbers. For the scientific men to govern the university of course they must be the majority, and that would be a long time hence; but I think that the requirement of a degree would make very little difference indeed in that respect, because there would be very few persons who had gone through the regular course at Oxford who had not taken a degree.

3930. I was looking to the abstract logical position of the proposal, and not to that which is based upon the present number of differently trained students. Practically I understand you to propose that the government of the university should rest with those who obtain classical degrees?—It should rest with those who have taken both a classical degree and a scientific degree for the future.

3931. That is to say, a classical degree with a minimum of scientific acquirement?—Or a maximum of scientific acquirement and a minimum of classical acquirement.

3932. (*Chairman.*) A man can take a degree at present mainly in science with a minimum of classics, can he not?—Yes.

3933. Or mainly in classics, with scarcely any science?—Yes.

3934. (*Sir J. P. Kay-Shuttleworth.*) I rather understood you to propose that the present classical requirements for a degree should be maintained under any circumstances whatever?—Yes, that is my view, speaking generally.

3935. I understand, therefore, that no person could arrive to the government of the university without fulfilling all the present classical requirements for a degree?—That is what I meant.

3936. I think I understood you to say that your chief hope that the cultivation of science would become more general among the students of the university, was the degree in which it was made a preparation for the professions, particularly the medical profession and engineering?—Yes.

3937. Having regard to the due elevation of character of those two professions, you would be of opinion, would you not, with scientific men generally, that the character of the scientific teaching should be maintained at the highest degree of theoretic excellence for those two professions?—Yes, I should think so.

3938. In fact, that it should not be degraded towards its merely practical applications; that such practical applications should constitute a subsequent course, but that the primary and initiatory course should be one of the highest scientific excellence?—I should wish to have the teaching of science kept up to the highest theoretical point attainable, but I suppose that to some extent practice is required to go along with theory, so that I should not wish to draw that absolute line between them.

3939. Having regard to that, is it not very clear that no excellence could be obtained in such a high degree of scientific culture without the devotion of considerable time to study?—Yes, I think so.

3940. So high a degree of scientific culture is not, I apprehend, to be regarded as included in the accessories to that culture which you suppose to be desirable for taking an ordinary degree at the university?—No.

3941. That high degree of scientific culture would, in point of fact, constitute, would it not, a line of separate study from that usually now pursued in the university?—Yes.

3942. And yet I understood you to deny to the persons who pursued that highest degree of scientific culture, and went through the most complete course, if they did not fulfil the requirements of the classical degree, any power in the government of the university?—Yes; but I would repeat what I said before, that they would be an exceedingly small number of persons. It is true that they do not get every advantage at Oxford, but there is a great practical good gained in my opinion by imposing the requirements which exclude them, and with which if they please, they can, without any difficulty, comply.

3943. Looking then to the fellowships, and looking to the means which might exist for the creation of a larger graduated professoriate for the purpose of scientific culture in the university, would not the exclusion of scientific students from the fellowships be an impediment to the application of collegiate funds for that object?—To a small extent, yes. The principle which I have several times repeated is, that I wish to combine literature and science, and that I should wish some fellowships to be given for the encouragement of science, but not to candidates who were wholly destitute of literature.

3944. The fact being, I believe, that a very small proportion of the funds of the colleges are now applied as rewards for scientific culture, do you or do you not regard it as desirable in future that a much larger proportion of those funds should be applied to scientific culture, either to increase the teaching power or to increase the rewards of those who devote themselves to that subject?—I will repeat again what I said before, namely, that I should wish them to be proportioned to the number of students. I would even go a little beyond the number of students, and give rather more encouragement in those subjects; but I should not throw open fellowships, or make scholarships, or found professorships, whether there were students to listen to them or students who could profitably hold them or not.

3945. Theoretically, is it not apparent that education is an advantage not sought by the uncultured, but one which has to be offered by centres of cultivation when it is not in the first instance fully appreciated?—Yes, I think so.

3946. And so with respect to scientific culture, if there be little of it now in the public schools and in the endowed schools, and in the universities, comparatively to the whole amount of culture, is it not apparent that the teaching power, the rewards and the opportunities must be increased in the universities before we could hope that the number of students would be increased?—I admit that you might stimulate it to a certain extent, but I think that there must be a certain proportion between what you offer and the number of persons availing themselves of it; and you might stimulate physical science to a degree which would not be advantageous even to the students of physical science, I mean if you gave fellowships and scholarships to students of physical science whether they deserved them or not.

3947. But if you began by continuing the existing system which excludes from the government of the university all who do not pass through the stage of classical study now existing, do you consider that a mode of encouraging the growth of physical science within the university?—I should consider that that would be the best mode, according to my view, of encouraging physical science, because I do not think that it is for the interest of physical science that it should be separated from literature, although I admit



that there may be a very few cases in which my proposal would work hardly.

3948. Having regard to the general interests of the country in which the application of the knowledge of the forces of nature to utilize the great material advantages of this country forms not only a part of the history of its social development, but necessarily a part of its social polity, do you think it desirable that the main education of the statesmen of this country should consist chiefly of literature?—I have never said anything which would lead to that conclusion.

3949. But if it were the fact that a cabinet existed in the government of this country in which the amount of physical science in comparison with the amount of literary knowledge was as 1 to 10 would it not be a grievous disadvantage to the country that it should be governed by a class of men so educated?—I may be prejudiced, but I should think that a cabinet which consisted of persons who only knew Latin and Greek would probably be a better cabinet than a cabinet consisting entirely of chemists.

3950. But my question was whether the opposite proportion was desirable?—I think it desirable that cabinet ministers, like other persons, should possess some knowledge of physical science.

3951. I think I might expect that you would admit that the cabinet should consist of men so educated as to be able to appreciate all the main general questions of science which might be brought before them?—Yes.

3952. That involves, does it not, a considerable change in the preliminary education given in the public schools and the endowed schools by which the character of the student coming to the university would be affected?—I would wish to give my opinion in the best way I can upon the subject before the Commission, but those are such remote considerations that I hardly know how to appreciate them.

3953. (*Mr. Samuelson.*) You have spoken of the combination of colleges for purposes of teaching. Would you have the kindness to say how that was brought about?—I think it was brought about from a sense of the general need. There were two steps taken about three or four years ago with that object. The mathematical lecturers of the university combined and allowed all their pupils to go to each other's lectures, so that they were able to offer a much more complete course of mathematics than any college could have given singly. Another movement in the same direction was made about the same time by the union of Balliol and New College, in which we have a system of common lectures; and since then I think most of the tutors throughout the university have a sort of intercommunion of lectures, and send their pupils from one college to another for their lectures.

3954. So, that combination has now become almost universal?—Yes, for purposes of honours. In my own judgment it must be carried further, and you must apply it to pass men as well. Pass men evidently require quite as great a division of subjects as the class men do, and it is impossible to supply that in any one college.

3955. So far as your knowledge of the statutes of the various colleges extends is there any impediment whatever in those statutes to prevent such a union?—None whatever.

3956. Or to prevent the appropriation of a portion of the endowments of the colleges to the purposes of scientific education?—There is at many colleges some fund which they could apply to physical science if the colleges were willing, but if they want to alter the number of their fellowships or scholarships at Oxford they have to obtain the consent of the visitor to doing it and also the consent of the Privy Council, this, however, would not cause any practical difficulty.

3957. In point of fact the colleges now possess all the powers which you think they would be likely to exercise for that purpose?—Yes.

3958. Would it be possible for the colleges to tax themselves for the purpose of raising a common fund

for scientific tuition to be placed at the disposal of the university authorities?—It would probably require some Act to enable them to do that. In some colleges they could do it, but there would be several difficulties about it; in many colleges they would have to take it out of their existing fellowships—literally to tax themselves. Then again, it would be very difficult to get them all to unite or to agree to a uniform tax. The smaller colleges would feel that they had a great number of undergraduates and a great staff to maintain, and that it was not fair to them that they should be made to pay as much as a rich college where there are comparatively few undergraduates. It is just possible to do it, but it is not a thing likely to be done, and I do not think that it would be done in a good way by the action of the colleges themselves.

3959. If the legislature were to interfere to bring about the establishment of such a common fund, do you think that it would upon the whole be favourably viewed by the separate colleges?—I do not think they would resist it, some of them would view it favourably, and others not.

3960. You think that it would not be looked upon as an undue interference with the privileges of the colleges?—It would be an interference of the same kind as was made 15 or 16 years ago by the Commission.

3961. You think decidedly that it would not be resented?—I think that some of the colleges would be very unwilling to give up their funds, but that, perhaps, is to be expected.

3962. With reference to the arrangement amongst the colleges which you contemplated for the purpose of providing a sufficient number of vacant fellowships and scholarships every year, is that an arrangement which can be carried out without legislative interference?—Yes, it can be, but with some difficulty, because it implies the uniform action of a certain number of persons who may not be all equally interested. It could be carried out by the assistance of the visitors. The colleges would only have to make application that they should be allowed to put off the election to their fellowships, and they would have a certain cycle when those fellowships or scholarships should become vacant.

3963. Both with respect to raising the funds, and also with respect to the rotation of fellowships, is it your opinion that if time were given, the colleges would be inclined to do of their own accord that which might now require some legislative stimulus?—I think they would do a great part of it. Many of the colleges would do it.

3964. You have stated that in spite of certain advantages possessed by physical science in regard to teachers, the schools of law and modern history have outstripped the school of physical science: has it occurred to you that this may be due in some measure to the fact of the atmosphere at Oxford being more congenial to the former subjects than to the latter?—It is difficult to say about that; it may be so to some extent. On the other hand, there has been much better teaching and much more eminent teachers in the physical science schools than in modern history.

3965. And for the very reason you have mentioned, would you not be rather led to the conclusion that Oxford is scarcely a place so adapted for teaching physical science as perhaps some other localities, say Glasgow, or some of the large manufacturing towns?—Chiefly for the reason, I think, that it is much more easy to connect those studies with the professions in great towns. I do not think that there is anything in the atmosphere of the place that is against it. More than 100,000*l.* has been appropriated at Oxford during the last 12 years to buildings and endowments for physical science.

3966. Would you look forward to any very large extent to Oxford becoming a place for the professional study of which you have spoken?—To a much greater extent than at present. I think it is quite possible.

3967. Notwithstanding the drawback that there is, a certain difficulty in connecting the teaching with practice?—Yes, I think it may be connected with it to a certain extent. Students may be induced to come

Rev.  
B. Jowett,  
M.A.  
16 Nov. 1870.



Rev.  
E. Jowett,  
M.A.

16 Nov. 1870.

by scholarships, and education may be given there as cheap or cheaper than it can anywhere else, and I see no difficulty in alternating, say Oxford education, with study at hospitals in London or at Edinburgh.

3968. With reference to the scholarships which you propose should be offered in rotation, would you endeavour to make them available for the unattached students, without their becoming residents in a college?—I think probably it would be for the advantage of the students themselves that they should reside in colleges, or be in connexion with colleges, but whatever scholarships you found for the purposes of physical science should certainly not be attached to colleges.

3969. They would, in fact, be of the nature of university scholarships?—Yes, they would be of the nature of university scholarships, but the students if they liked would have the power of belonging to any college.

3970. You have spoken of preliminary as distinguished from professional education, do you think it is desirable that Oxford should continue to be so much as it is now a place for preliminary education?—I hoped that we might retain what we have at present and add something of professional education. I do not consider that for the mass of students at Oxford, their time is at all properly filled up at present. I believe that a great deal more might be done, and that a part of the reason why a great number of our students work so much less than they ought to do, is that what they learn has no direct connexion with their future profession.

3971. With regard to the study of Greek as bearing upon the studies at public schools, I think you have expressed no opinion as to whether it would be desirable to continue the study of Greek in the public schools?—I am in favour of continuing the study of Greek in the public schools; not requiring all the boys to learn Greek, but making Greek one subject necessarily taught in the school. I do not mean that I would continue Greek in every school where it is taught at present, in every small grammar school that has an endowment of 50*l.* a year, but in the principal schools I should continue the study of Greek, and I think it is quite possible to add to that some study of physical science as well.

3972. You think that the study of Greek would not prevent the study of physical science to a sufficient extent to enable a young man to profit by the amount of his acquirements in science as a preparation for coming up to Oxford?—I think not.

3973. With respect to the amount of classical acquirement which you would require from a person taking a scientific degree, would you limit it to that amount which is now required in the examination for moderations?—Yes; I should not require more than at present at moderations, and none is now required afterwards.

3974. But so far as the two schools are comparable, you would require as much science from a literary student as you would require of literature from a student in science?—With respect to that I am not prepared to say yes or no. I think I would wish to leave it in this way, that I am prepared to demand Latin and Greek and a fair amount of science of everyone; but I

am not prepared to say, considering the small amount of physical science that is at present taught in the country, that I would make the amounts equivalent.

3975. (*Chairman.*) Have you considered the question whether it would be desirable to diminish the number of fellowships and apply the funds to university purposes?—I think that if the object sought could not be obtained without, some diminution of the fellowships would be advantageous; on the other hand, that runs up into another question, namely, how the fellowships themselves should be remodelled. I think that fellowships fulfil a very important purpose, partly in supplying teachers to the university, and still more in supplying to young men the means of passing through the university into a profession. That is a very great good which they do at present, and I should not like to see it materially infringed upon. That a number of highly educated young men are able to go to the bar or to some other profession having leisure and being free from pecuniary anxiety, and not being compelled to slave for the press or lose their time for the sake of making money for seven or eight years of their life, seems to me to be a very great national good, and I should not wish to see that use of fellowships infringed upon, but the property of the colleges is greatly increasing, and I think we can afford to supply a considerable sum for university purposes, without seriously affecting the number of the fellowships.

3976. Should you like to see a larger proportion of fellows employed in actual teaching at Oxford?—Yes, we have always a great difficulty about teachers. In fact, at Oxford the whole thing seems to require to be reconstituted; there is such a difficulty in keeping the best men there, and they stay for so short a time. If we are to keep men as teachers, we must get rid of the condition of celibacy.

3977. (*Marquis of Lansdowne.*) How far do you consider that one of the functions of Oxford is to be a head quarters, not only of scientific instruction, but of scientific research?—I think so certainly, but the relation between teaching and research is a very difficult question. I am inclined to think that teaching does not altogether succeed without some original research, or at least without some originality of mind, and yet it is certainly very hard on a man of original genius to have to be employed in giving lectures instead of pursuing investigations. My view is that the teaching gains a great deal from original genius, but I do not think that original genius gains much from the teaching. I should think it necessary that Oxford should be a place of original research as well as of scientific teaching; but then original research is a very precarious sort of thing; you can get a professor who can give a lecture, but you cannot get a man for money who can make a discovery.

3978. But at the same time the amount of work expected of scientific men now at Oxford is such, is it not, as almost to preclude the possibility of their devoting their time to anything but the mere hard work of teaching?—I think not; but I would rather that the scientific professors should answer for themselves upon that subject.

3979. (*Chairman.*) Are there any other points upon which you would like to favour the Commission with your opinion?—I think not.

The witness withdrew.

Adjourned to Tuesday next at 12 o'clock.



No. 6, Old Palace Yard, Westminster, Tuesday, 22nd November 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

THE MOST HON. THE MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

THE REV. JOHN PRIDEAUX LIGHTFOOT, D.D., examined.

3980. (*Chairman.*) I believe that you are Rector of Exeter College, Oxford?—I am.

3981. What is the number of students at present at Exeter College?—At this present day there are about 160 undergraduates in residence; there may be two or three more or less.

3982. What is the number of fellows in your college?—We have 15 fellows under the new ordinances.

3983. How many of your students are studying science?—At this present time a smaller number than usual are studying natural science; I think there are only five and of those five only one is attending at the museum. Three are drawn off from their special work of natural science by other University work; having examinations to pass, which press upon them, they have for this term given up attendance at the museum. I think we numbered seven or eight when the questions were sent me by the Commission, but at this moment I think that we have only five.

3984. (*Professor Stokes.*) What is the standing of that student of whom you have just spoken?—He is about half way through his course.

3985. (*Chairman.*) Has the number usually been about seven or eight?—I should think not more. I have looked back for some years, and I should think that that is a tolerably fair average of those who have been studying natural science with real attention; there are other men who have attended lectures for a certain time, but have not studied the subject to any great extent.

3986. How many of your fellows might you regard as having obtained their fellowships by scientific studies?—Not one has obtained his fellowship on account of his knowledge of natural science. One obtained a first class in the natural science schools, and also a first class in mathematics. His having obtained a first class in natural science might have had great weight in an election, although, from his knowledge of mathematics, I think I may say that he would have been elected without it.

3987. How many mathematical fellows are there in your college?—We have only nine of our present fellows who have been elected since the University Commission, and of those nine, three have obtained the highest honours in mathematics, but only one the highest honours in physical science. The last fellow whom we elected for mathematical knowledge had studied physical science to some extent, and I believe he intends to resume the subject, having now taken his degree.

3988. Are you doing anything in your college now to encourage the study of science?—When the University Museum was built, we immediately appointed a lecturer on natural science, and we continued to have a lecturer, I think, until about the year 1865. Then, we elected a fellow who we thought might have time to lecture on natural science. The lecturer who was giving lectures in our college on this subject, left the University, and the fellow whom we elected, having the double knowledge of mathematics and natural science, found that his time was entirely occupied by his giving lectures in mathematics, and at this present moment the only way in which we encourage natural science is by giving

rewards of books to those who take honours in that science, and by returning a part of the students' fees. The year being divided in Oxford into three parts, each student pays seven guineas three times a year, and of the seven guineas we return five in all cases, if a young man attends with diligence at the museum. The students pay seven guineas for three years, and three guineas as long as they are in residence afterwards, five out of seven for the first three years are returned, and two out of three for the remaining one or two years, during which time they may be working at the museum. The number of students, however, at the present time offering in physical science schools, is not nearly what it was eight or ten years ago. A statement was made that some young men got up their subjects for the natural science schools, in whether it was three weeks or six my memory does not serve me, but in some a very short period. It was supposed by the undergraduates at the time that the examination afterwards became very much more severe; whether this was, in reality, the case, I do not know, but whereas eight or ten years ago a considerable number of young men obtained a pass in natural science, now very few indeed offer. The schools have almost entirely become honour schools. I think it is to be lamented, but that is the case.

3989. When you engaged a person to teach science, was he in any way connected with a scientific professorship?—One was a professor; he shortly after left the University. The person who was the longest time employed by us was not a professor; but we found it a very great inconvenience in the employment of a teacher who mainly instructed in only one branch of the subject. It seems to me that separate colleges can do very little to promote the direct study of natural science; there might be a union of several colleges as there is now for mathematical teaching, and the teaching of history, and, indeed, for other subjects; then I think possibly some good might be effected. But even then it would be very doubtful whether it would be for the advantage of the University that such a system should be adopted by the several colleges, unless natural science was studied by a very much larger number of men than is the case at present. If the pass students were as numerous as eight or ten years since, I think a tutor or a lecturer closer at home might be of very great service in keeping young men in working order. With regard to candidates for honours, however, if further assistance is provided for them, I think it had better be given through the professors, and entirely under their control.

3990. I rather wished to ascertain whether the teacher employed at Exeter College was quite independent of the professors, or gave his instruction in connexion with them?—For the most part independently.

3991. Do you think that any other steps might be taken than those which you have already indicated to encourage scientific teaching?—More scholarships and fellowships might be given. We have 22 scholarships in my own college; of those 22 only six are at this moment held by mathematicians, and of nine exhibitions, three are held by mathematicians; not one has been given for physical science. One or two of our scholars, however, have studied physical science with very great success; indeed, two of them have this term

Rev.  
J. P. Lightfoot,  
D.D.

22 Nov. 1870.



Rev.  
J. P. Lightfoot,  
D.D.

22 Nov. 1870.

been aiding in the work of the museum. One of these has obtained a fellowship in a college, I believe chiefly owing to his knowledge of natural science, and another a university fellowship.

3992. Have you ever offered scholarships for science for which there have been no competitions?—We have only offered scholarships for mathematicians, but we offered two fellowships for all the subjects studied in the University, and there were two competitors who had made natural science their study only two years ago. Three of the most eminent professors in the University examined them, and made their report to us. The fact that very many of the best classical scholars in the University were also competitors, may have prevented more natural science students from offering; but having some of the best classical scholars in the University as candidates, we did not elect a natural science student, but two classical students: a Craven scholar, and another candidate who afterwards obtained the prize for the Chancellor's English Essay. The election of such men could reflect no discredit on other candidates.

3993. Do you labour under any legislative disability with respect to the furtherance of science?—None whatever; we are perfectly free both as to our scholars and as to our fellows; we may from time to time determine the subjects in which both scholars and fellows shall be examined, and, indeed, as a matter of fact, this very last year it was long under discussion whether we should elect to a mathematical fellowship or one of natural science.

3994. Would the college authorities be at liberty to contribute to an University fund for the purpose of encouraging physical science?—Not, under the present statutes, out of the college revenues strictly so called.

3995. (*Professor Huxley.*) Do you think that the colleges would be disposed to supplement the teaching of the professors at the museum by supplying tutors, and what the French would call *répétiteurs* or demonstrators, who would work under the direction of the professors?—I think there would be more probability of their supplementing the museum in that way than in assisting science through the appointment of lecturers in the college.

3996. That probably would be a much more convenient and economical course than endeavouring to set up local laboratories of their own?—As far as my own opinion goes, but it is worth nothing upon such a matter (for I am, as a former witness said, entirely an outsider), I think that would be by far the better plan as a matter of administration. With such able professors as we have at present, persons who throw their whole soul into their study, I think it would be far better for them to have the whole work under their control, than to have natural science taught, as it is now, in one or two colleges where the teaching is not entirely under their own control.

3997. (*Chairman.*) May I understand from your last answer that you would connect the science teaching in the colleges directly with the scientific teaching of the University?—I should wish to see that course pursued; and I believe it would be pursued with very much more success than the other system.

3998. Have you funds available for teaching science which are not at present required for the general purposes of the college?—We have no funds available except the very large funds which the young men in so large a college themselves contribute; these and the establishment fees, and a small portion of our room rent, now divisible amongst the corporate body, are entirely under our own control.

3999. Are they contributed in the shape of fees?—Each young man pays, as I have stated before, seven guineas three times a year, and after his third year of residence he pays only three guineas three times in the year, when resident. He also pays fees as establishment charges. I have brought with me a small college manual (*producing the same*), which gives the particulars of such payments as far as relates to Exeter College.

4300. The payment of seven guineas a term is

charged, I presume, for tuition?—That is a charge strictly for college tuition, and is all spent in that way with the exception of about two or three hundred pounds a year, which is reserved for any special cases, and sometimes for assisting a very poor student to get a private tutor, or to relieve him of a portion of his fees; or, in part, for the return of tuition money in the cases of students attending the museum.

4001. Then that sum mainly goes to provide tutors?—Yes. I thought it would be interesting to the Commission, and I have, therefore, brought with me a list of the college lectures this term, and the money is all distributed in the payment of the persons who give the lectures named in the list. When I say all, I except the small reserve fund which I have just mentioned. (*The following list was handed in.*)

#### Lectures, Michaelmas Term 1870.

Mr. Sub-rector -	Ethics I.
„ Sub-rector -	Logic, part III.
„ Sub-rector -	Divinity and Logic.
„ Sub-rector -	Collossians.
„ Sub-rector -	Saint Mark
„ Boase -	English History.
„ Boase -	Political Science.
„ Boase -	History and Law.
„ Boase -	English Law. English History, No. 2.
„ Tozer -	Tacitus: History.
„ Tozer -	Greek and Latin Lit.
„ Tozer -	Verses.
„ Tozer -	Soph.
„ Tozer -	Euripides.
„ Hammond -	Logic.
„ Hammond -	Textual Criticisms.
„ Hammond -	Livy. XXIII.
„ Hammond -	Old Test. and Articles.
„ Jackson -	Latin Prose.
„ Jackson -	Hom. Od. I.
„ Jackson -	Cic. Phil.
„ Jackson -	Ethics I.
„ Jackson -	Aeschines.
„ Jackson -	Greek Prose.
„ Bywater -	Rep. I.
„ Bywater -	History of Logic
„ Bywater -	Odyssey IX.
„ Bywater -	Mods. Books. Juvenal.
„ Price -	Euclid and Arithmetic.
„ Price -	Algebra.
„ Price -	Mathematics.
„ Pelham -	Greek History.
„ Pelham -	Roman History.
„ Pelham -	Horace.
„ Pelham -	Cicero.

4002. Are these courses of lectures given during this term?—During this present term; but with the very large number of men which we have at Exeter, and so many subjects in classics in which lectures must be given, if we are to pay our tutors well, although there is such a large payment, we have not much more money than is required. If there were more students in natural science, then there would be so many drawn off from classical lectures, and more money might be paid for instruction in other subjects.

4003. It would appear that you have nearly 40 different courses of lectures?—Yes, but at some of those lectures young men are received from other colleges. There is an union now between several colleges; the mathematical lecturer of Exeter College, for example, unites with the mathematical lecturers of three or four colleges.

4004. The small colleges unite for these purposes; the lectures are not open to the whole of the University students, I believe?—Not strictly so; and certainly not without the leave of a man's own tutor, but at some colleges students are received from more colleges than are directly in union for the purposes of instruction in some specific subject. University, Balliol, Merton, and Exeter are united for mathematical teaching; and if any of those colleges happened to be in union with some other college for other than mathematical teaching, I believe the students of such other college would be received into the mathematical lecture also.

4005. What is your opinion as to the extent to



which literary and scientific studies should be united?—That is a very difficult question, one of the most difficult questions, and one upon which no two persons entirely agree. However desirable it might be that scientific studies should be more pursued than at present, I do not think that as yet a knowledge of some subject in physical science could be required as in every case necessary for a degree, and I believe even some of the professors of that science would not at present desire to see it made a *sine quâ non*, because they particularly dislike a smattering of knowledge. I fear that Oxford, at present, as far as its pass-men are concerned, is suffering very much from the fact that already they must offer in two schools; compel them to offer in a third school, and the evil might be greater. I would far rather see that a man studied classics, or mathematics, or scientific subjects to some good effect, and show his mind somewhat disciplined, than that he should get a degree through a smattering of all. The knowledge of the man who obtains a low honour in *one* school is, I believe, of far more value than the knowledge of the man who obtains a pass through two schools.

4006. Is it not the case that a man can obtain a degree for classics alone, or with scarcely any admixture of other knowledge?—He must know a certain amount of mathematics, but it is certainly not a very large amount.

4007. Nothing more than is required at moderations, I believe?—No, nothing beyond moderations, and even at this examination he has the option of logic.

4008. After moderations, he may apply himself solely to classics, may he not?—Yes, after moderations he may apply himself solely to classical literature, to law and modern history, to mathematics, or to natural science; or he may select the new Divinity school.

4009. And he may go out, may he not, in any one of the schools?—Yes, if he takes an honour in those schools, not otherwise; if he does not take an honour, he must go out in two schools.

4010. And must one of them be a mathematical school?—Not necessarily; one must be a classical school, but the student has his option as to the selection of a second school. His pass work in mathematics for responsions is arithmetic and Euclid, the first two books, or algebra up to simple equations inclusive. For moderations he has had to pass in algebra, including quadratics, and surds, and in Euclid the first three books, unless he has preferred logic.

4011. Is that all the mathematics required for a degree?—Yes, that is all the mathematics that are required.

4012. How much mathematics is required for a degree?—The pass mathematics required in the final schools are algebra, first part of Colenso, or the first six books of Euclid.

4013. (*Professor Huxley.*) Do you not think that the essential characteristic of a University degree, as distinguished from other kinds of degrees, or expressions of qualification, is that it should be some sort of evidence that a man's knowledge is of a general character, and that his faculties have been generally disciplined?—Under its old and present systems, Oxford has endeavoured to discipline a man's faculties by as general an education as it could carry out. The pressure from without is tending to change that system, and make the education more special.

4014. Is it your opinion, considering what science is now-a-days, that a man can be said to be so disciplined who is entirely ignorant of all branches of physical science?—No, I should most assuredly say he was not generally disciplined, if science has been wholly omitted.

4015. Do not you think that it would be very much better that all persons taking an University degree should have been compelled to pass through by no means a superficial study of both literature and science, but to be well grounded in the elements of both; and then, if they like, afterwards to specialise themselves in particular departments?—I think, taking the calibre of our students, this double study carried out to the

extent you wish, could not now be secured without depriving many men of a degree. Whether that would be an evil or a good is another question; but there are some who study with fair diligence for three years to obtain even a pass degree, partly, it may be, owing to deficiency in early education; but that deficiency being what it is, we could not at once enforce the double study in all cases, nor would our honour men be equal to it without some sacrifice of their special study.

4016. Supposing you had to deal with a *tabula rasa*, and had your human material of the kind you wished, do not you think it would be very much better that an University degree should be given to those persons who had a general and not a one-sided training?—My answer has been supplied in a former answer.

4017. Do not you think that the University runs very great danger of being converted into little better than a technical school, that is to say a professional school rather than a University, if persons are allowed to take their degree either in science, or in literature, as a literary person entirely for literature, and a scientific person entirely for science?—But that is not the case at present.

4018. But that is rather the tendency, is it not, of the University at present?—It is the tendency, and there are persons who would have the classical course discontinued earlier; on one point I think there might be a change somewhat to meet their views. Many of our young men, not only those from the smaller, but from the larger schools, are obliged to spend much of their time in an attempt to work up Latin prose. With some of our pass men it is a great stumbling-block. Whether an amount of natural science might not be accepted in lieu of Latin prose for the moderations, is a question which might be very well discussed by the University. For the responsions a certain amount of Latin prose is required, and I have looked again and again at the Latin prose required at this examination for pass men, and the Latin prose required at moderations, and I am bound to say that I can see very little difference, if any, in the quality of the prose required for the one and the other examination. If that be the case, I should be quite ready to allow pass men the option of declining any further study of Latin prose composition after responsions. I should not be as ready to give up Greek altogether, or to allow men, as some would, to offer for their classical examinations even at their first term if ready for them, devoting themselves afterwards to other than classical studies. The lectures would be brought down to the lowest standard, instead of being, as now, somewhat raised towards a higher. And not attempting to discuss the question of giving up Greek altogether, but supposing its study were retained as it is at present, I would continue to insist on the study of the classics for the first year, although a student may have shown, perhaps, that he had attained such an amount of knowledge as would enable him to pass his examination in moderations. The standard of the lectures is rather raised by having a certain number of good men in the lecture; it is better for the lecturer, and it is better for those to whom he lectures.

4019. I judge from what you have said that you would consider it a very great misfortune for the University if a man were allowed to take a degree in the University for science without any tincture of literature?—I should think it a great misfortune. If such a course be adopted, let us be honest; let us call the degree by another name.

4020. In that case the University would be converted into a merely technical professional school?—Yes. I should be very sorry to see it so, but, as you are aware, there are some persons who desire that such a course should be adopted: if it be, I can only repeat that I hope that another name would be used, that people may thoroughly understand what this degree, and that degree, means.

4021. Do you not think it also true that a person who has exclusively literary culture without scientific

Rev.  
J. P. Lightfoot,  
D.D.

22 Nov. 1870.



Rev.  
J. P. Lightfoot,  
D.D.  
22 Nov. 1870.

culture is equally one-sided?—History would hardly support such a view.

4022. If you went back to the palmy times of Greek culture, they would no more have thought of excluding the science of that day from their culture than they would have thought of excluding the literature of that day; is not that so?—No doubt this was the case.

4023. Do not you think that, considering the enormous place which science now occupies, not only in the practical world, but in the speculative world, a person who has only literary culture must be regarded as one-sided?—His knowledge is as you put the case, one-sided certainly, but the B.A. of Oxford and Cambridge tells its own tale, and has been supposed to imply a certain degree of mental culture. You would wish it to imply more by refusing the degree to every person who had not studied some one subject of physical science; and no doubt such a double study would be very desirable if the calibre of men were equal to it at the age they usually take their degree, and it could be secured without any sacrifice to the present studies. Let them stay longer at the University, you may reply, or refuse a degree altogether to persons who have not a sufficient knowledge of science.

4024. Might I suggest that there is a third possibility, and that is to improve the education in the schools which send those people up; would not that meet the difficulty?—Having examined so many men just come up from school, I must allow that in very many cases there is ample room for further culture. As it is we try to encourage other studies in the schools. There are certain classical and mathematical subjects in which we examine men for matriculation, but we always give men the option of bringing up science or history if they like as a makeweight, and a knowledge of one or the other of these subjects would save them very often; but I have never known any one instance that a man offered to be examined in natural science. In our Matriculation Paper it is stated, "Weight will be given to any additional books or subjects in which candidates may desire to be examined." That passage is inserted with the hope of encouraging any school which may study history or science to any special extent. However, admitting that education is one-sided, without science, yet looking at the amount of work done by our honour men with their present preparation when they come to the University, it might still be a question whether they could bear the further weighting of natural science.

4025. (*Chairman.*) What would be your opinion as to gradually raising the standard of the matriculation examination, and of responsions?—The matriculation examination differs from that for responsions; the one is carried on by each special college, but the responsions by the University.

4026. Have all the colleges a matriculation examination?—I believe all. I am not aware of any one college which has not a matriculation examination, and at present it results in the rejection of a very large number of the young men. I think 17 offered at Exeter at the beginning of this term, and only seven succeeded; this number of failures was, however, exceptional.

4027. You would hardly be prepared, then, to recommend raising the standard for matriculation?—I do not think that, the schools being what they are, we could do it except gradually, or if we did, we must shut out many from the benefit of an University education, and the failures do not relate only to young men who come from private tutors, or from the smaller schools; they extend, I am sorry to say, to the larger schools. Perhaps my experience here may be worth not much, but I was tutor from the year 1827 to the year 1834, and I am bound to say that in my opinion the Latin prose presented to us now from the inferior men is somewhat worse than the Latin prose which was presented so long ago as that time. I am struck year by year more and more with the miserable attempt at Latin prose that is made by some of the candidates for matriculation, and I should say that very many more failures in the University

examinations arise from inability to write Latin prose than from want of knowledge in Greek or Latin books.

4028. (*Chairman.*) I do not understand you to say that you consider the standard of school education as a whole to be declining?—Quite the reverse. Men come up now sometimes very fairly acquainted with modern and ancient history; and although I am not prepared to say that the scholarship of the best men is very much in advance of the scholarship of the best men 30 or 40 years since, yet compared with the whole numbers sent up there are more fair scholars treading upon the heels of the best men; and I cannot but have some fear that in some schools the great attention that is paid to the better men is paid to them to the neglect of the inferior.

4029. The school standard I suppose must depend in a great degree upon what is required from young men on entering the University?—By degrees it must, because if a large school finds its young men sent up to Oxford and rejected, the rejection must have an effect upon the school. I remember Dr. Temple sending up a pupil with good recommendation; unfortunately that pupil failed to satisfy the College, and I wrote to Dr. Temple, thinking that he would be very much distressed about his pupil's failure, but he wrote to me in reply, "I cannot tell you what service you have done my school. I cannot make the boys believe that anybody in Oxford cares about arithmetic. You will have done much good by sending that young man back."

4030. Do you not think that the same would apply to the teaching of elementary science, and that if the University required it at entrance, the schools would send their young men up sufficiently qualified?—If required by the University, the immediate effect would be that it would be taught in schools.

4031. But still you are not prepared to recommend that it should be required at matriculation?—I am not prepared for that at once, but I very much desire that in all matriculation examinations the pupil should have an opportunity of shewing what he does know in physical science or in any other subject, and to let his knowledge be a sort of makeweight.

4032. You still would leave it voluntary with the pupil?—I should rather myself at present leave it voluntary.

4033. Voluntary do you mean to a man on entering the University, as well as subsequently when obtaining the degree?—Yes, allowing natural science to have its weight, I would rather gradually press for a better knowledge of classics and mathematics at entrance, and until young men come up better prepared, I do not think we could require more than at present from the mass of men. I may, however, be allowed to observe that there were a great number of men at Oxford a few years ago who almost by compulsion attended natural science lectures, because then no one could take his degree unless he had attended two courses of some professor's lectures, but the professors themselves were the persons who remonstrated against the system. They said that they had their class-room filled with men many of whom paid no attention to the subject whatever, and thus a system was given up which to a certain extent worked good. I have heard a professor of natural science say that some of his best students have been those who were forced into his lectures at first. As far as my own college is concerned, everything relating to the education of the college is in the hands of an educational council, and not in the hands of the fellows generally; and although we might be opposed to insisting, in all cases, on the study of natural science, that body, I think, would willingly encourage its voluntary study, giving a scholarship now and then, and perhaps a fellowship for proficiency in natural science, but every election of a natural science scholar would take away a student either from the higher classical or mathematical lectures room, and it is important to keep up a class of a certain number. We did at one time ask questions on natural science in our scholarship examination,



but we found that the answers did not sufficiently tell to continue the system.

4034. (*Dr. Sharpey.*) You spoke of the large revenue obtained from fees paid by students, and its application, but of course there are other sources of revenue belonging to the college?—Yes, there are the revenues that were left us by the founders.

4035. To what are they applied?—They are applied to the support of the fellows and partly to the support of our scholarships, and also in part to the maintenance of the estates in good order; for this purpose we deduct 10 per cent. from all our rents before we divide any revenues. These, however, are small; in fact, only about 5,000*l.* a year from land. In addition, however, to this income, there is also the room rent of the college, the disposal of which is settled by statute, with the exception of about 500*l.* per annum, which now forms part of the fellowship dividend.

4036. You spoke favourably of the plan of aiding in the teaching of physical and biological science by supplying répétiteurs, or sub-professors, assistants, and the like. From what source would their stipends be derived?—First, if the University were pleased to be liberal, as it has been in support of science of late years compared with its pittance in earlier days, and as I believe it would be now if need were shown, it might be disposed to grant some further assistance; but if not, the colleges might give some aid. However, I cannot, of course, answer for either the University or the colleges, but supposing that there were a large number of students in natural science, the returning of the tuition money as we do, and as I believe other colleges do, would in part meet the difficulty.

4037. I think we have been given to understand that the University have expended nearly the whole of their resources in what they have done already for physical and biological science; is that the case?—The University at present has a very small surplus of annual income at its disposal.

4038. Supposing the colleges, Exeter College for example, were disposed to apply any part of their general revenue, as distinguished from the fees for teaching, towards the maintenance of teaching physical science in the University in the way you have mentioned, would they have power to do so?—They could only do so under the present statutes with the consent for the time being of each individual fellow, who must be consulted and asked, "Will you give up a portion of your income?" and I do not think it would be quite fair or expedient to put such a test to a fellow because as it is we cannot keep for any long time some of the best men in the University; the pay that we give to our mathematical or classical teachers is not sufficient to retain them there. Two of our ablest fellows during the last year have left us for appointments in the country which offered greater advantage.

4039. There would be no fellowships to spare, none that you regard as superfluous?—In my own college I can hardly state what may be the result by-and-by. We have two or three fellows far advanced in years; and out of the present fifteen, nine only have been elected since the new ordinances; then again, how far it may be expedient to allow so many non-resident fellows is a question which must soon be considered, but with the present number of non-residents, our fellowships are not too many.

4040. The college authorities have it within their own power, have they not, if they thought fit, to suppress any of the fellowships, and to apply what would accrue from such suppression to the maintenance of the teaching of physical science?—We have the full power, if we please, to suppress a fellowship, subject to the assent of our visitor, not the Crown in our case. There are three colleges in Oxford which are circumstanced as Exeter is. These colleges made terms with the Commissioners before a certain date, and having made terms with the Commissioners before that date, the appeal is to the visitor in all cases, and not to the Crown. If the college thought that one or two

fellowships could be suppressed, it would have the power of suppressing them, but I certainly do not think the college would be so disposed.

4041. Without going to the Legislature?—Yes, we should not have any need whatever to do that. We have the full power to alter our statutes I believe to any extent with the consent of the visitor; no legislative enactment would be needed at all.

4042. (*Chairman.*) What proportion of your fellows are actually doing college work?—I think eight at this present moment.

4043. And are the rest non-residents?—The rest are, with the exception of a probationer, all non-resident.

4044. Nearly one half are non-resident?—Yes, we have eight in residence; so that somewhat less than half are non-resident.

4045. (*Professor Stokes.*) You stated, did you not, that one of your fellows had taken a first class in physics as well as in mathematics, but he was unable to lecture in physics because he was occupied in lecturing in mathematics?—He is fully occupied in lecturing in mathematics, and he is not now, I believe, pursuing his studies in physical science; he has found that mathematics require his undivided attention, having regard to the number of pupils that he has in Exeter, and those he receives from other colleges.

4046. But yet there are other fellows, are there not, who have taken high degrees in mathematics?—Of the nine present fellows elected since the ordinances three have taken the highest honours in mathematics.

4047. And who therefore would be fully qualified to lecture in mathematics?—Yes, but one has discontinued the study; he is a very good scholar, and he has of late preferred to devote himself to classics. Another would certainly be able to lecture, but I believe that he is very much disposed to follow the line which his father, Professor Donkin, followed with so much success. He was only elected last summer, but he has a considerable turn for natural science, and I think it is not unlikely that he will devote himself more to that than to mathematics. At present he lectures in mathematics in another college.

4048. But he does not lecture on physical science?—He does not.

4049. In the election to fellowships do you look to the wants of the college as regards a lecturer in this or that branch?—Yes, and last year it was proposed that we should elect a fellow for proficiency in natural science, but the majority thought that the instruction of so large a college must not be allowed to depend upon one mathematician, and we therefore settled to elect for proficiency in mathematics.

4050. Do you find that the teaching power of the college practically suffers through the non-residence of the fellows?—If it is right that every college should teach natural science it does, because if we had a good tutor in place of a non-resident fellow who never took any part in tuition, and is never likely to do so, it would be an advantage to us, supposing that to have a lecturer in the college on natural science is the best system. We have fellows enough, and not more than enough, in residence, to carry on the large course of lectures of the college; in fact, at this moment, if one of our classical tutors were to leave us, with the few men who are studying mathematics or natural science, and with the large number of men devoting themselves almost entirely to classics, we should be obliged to elect another fellow to become a classical tutor, unless some fellow returned to residence, or we went out of the college for another tutor. Indeed one of our present tutors is not now a fellow, but has continued tutor since he ceased to be a fellow. We have also at this moment a member of another college who gives aid in the classical instruction of the college.

4051. (*Chairman.*) Do you expect all your fellows to do some college work before they become non-resident?—There is no such regulation. We have the power of mulcting the non-residents to the extent, I think, of half their fellowships on going out of resi-

*Rev.*  
*J. P. Lightfoot,*  
*D.D.*

22 Nov. 1870.



Rev.  
J. P. Lightfoot,  
D.D.  
12 Nov. 1870.

dance, but the paper upon which the power of mulcting is written is almost waste paper. When a man is elected we have again and again threatened that in the event of becoming non-resident, the mulct should be imposed, but we never have had the courage to carry our threat out. If there is to be a difference between the stipend of a resident and non-resident fellow, that difference should be defined by ordinance, and not left to the option of brother fellows.

4052. Do you mean a college ordinance, or some extrinsic power?—A college statute.

4053. (*Professor Stokes.*) Is the tenure of your fellowships subject to the condition of celibacy in case of non-residence?—The tenure is so in the case of all our fellowships, for no change in this respect was made by the University Commissioners, although some change was made in regard to lay tenure. A good deal of stress was laid upon the colleges to make a certain number of the fellowships lay fellowships, and we compromised the matter with the Commissioners by enabling all fellows, excepting of course the chaplain, to retain their fellowships as laymen for 15 years, which was about the time at which the fellows were obliged under the old statute to take holy orders, but with this addition, under the new statutes, that if a man has worked 10 years for the college in educational work he might then retain his fellowship as a layman for life. If he has done actually 10 years' work he may retain his fellowship without being obliged to take holy orders; or, if at the time that he would have vacated his fellowship, that is to say, at the time that the 15 years have elapsed, he is engaged in college work, he may retain his fellowship so long as he is engaged in college work, remaining a layman.

4054. May I ask your opinion as to the desirableness of free tenure by non-residents?—I think that a change is absolutely necessary, and in fact I even ventured to mention to two or three of our fellows some time since that I thought the time was very nearly come when some change must be made in the direction of curtailing freedom of tenure, or of reducing the income of non-residents. Perhaps the one course would be rather better than the other, the reducing the income of the non-resident fellows. I do not say in what degree, possibly to the amount of half their income, in the case of men hereafter to be elected.

4055. What is the value of a fellowship in your college?—Upon the average from 230*l.* to 240*l.* It was very much larger last year, but this arose in part from accidental circumstances, as there were two or three vacant fellowships. The revenue from the vacant fellowships is by statute ordered to be divided among the fellows, and as last year we happened to have two vacant fellowships, the income of the remainder was thus much increased. Perhaps last year, with the allowance given to residents, the fellowship would have been worth 300*l.*, but 240*l.* is about the average value of a fellowship shared by residents and non-residents, except that a small sum is given to the residents of about 2*s.* a day.

4056. I suppose there is no difference between residents and non-residents in point of amount?—No difference, except the allowance of 2*s.* a day and rooms rent free.

4057. You are obliged, are you not, by statute to elect to a fellowship by the result of competitive examination?—Yes, the words of our statute are, "preference shall be given to those candidates in whom shall be found the highest moral and intellectual qualifications, such intellectual qualifications having been tested by an examination in such subjects as the college from time to time shall determine." Ours are all new statutes. Most of the colleges retain their old statutes, which have full force save wherein limited by new ordinances; but we made wholly new statutes, and the commissioners, I believe, at one time were led almost to doubt whether they had not a little exceeded their powers in sanc-

tioning them. However, the statutes were laid before Parliament, and were not objected to.

4058. At what standing, reckoning from the B.A. degree, do men commonly obtain fellowships?—Of late years, at Exeter, they have not obtained their fellowships quite so early as they used to obtain them. Even when there were a great number of restrictions men obtained their fellowships at an earlier date, because men were qualified then to become candidates when of about two years standing. If I were to say that the standing of fellows now elected was about midway between the B.A. and the M.A. degree, that would be as nearly as possible the truth. No preference, you are aware, is given at Oxford to the members of our own colleges; it is not professed to be given, and I do not know that, except in the case of *ceteris paribus*, that any preference is given.

4059. Does it often happen that a man is elected so late as three or four years after his B.A. degree?—Yes. There are cases in the University of Masters of Arts elected, and of Bachelors of Arts of M.A. standing.

4060. Do you think that it is a good discipline for the mind to go on reading for three or four years after the bachelor's degree, with a view to examination, to producing on paper?—You can only judge by the effect, and there certainly seems a very marked difference in the work of a man just out of the schools, and that of a man who has been reading for a fellowship for two or three years. The papers of the latter often give witness to much increased mental culture.

4061. You do not think that his reading is cramped and confined by the prospect of the examination which he has to pass?—There are instances where that effect seems to have been produced on prolonged reading, but not enough to enable me to speak of them as cause and effect; however, I have seen men who have done good work when they have come out of the schools, and yet having been hard students for a year or two, afterwards have not sent in papers equal to their former work.

4062. My question had rather reference to the profit of the man himself than to the degree in which you may test his proficiency. Do you think that it is profitable for the man himself to have his reading confined by the prospect of the examination which he has to pass so as to be rather prevented from extending it in the directions in which he feels the greatest desire to do so after he has taken his bachelor's degree?—If the study itself be good I suppose the extension of the study would be good also.

4063. It is rather limitation in confining the direction, than extension, that I refer to?—If Oxford rightly does devote as much time as it does to philosophy, I think philosophy would hardly be fully studied (using the word philosophy in the technical sense in which it is used in the University), and I suppose few men would say that it was sufficiently studied, at the time when a man graduated. From my own experience I should say the faculties have been rather expanded than cramped.

4064. (*Sir J. P. Kay-Shuttleworth.*) I conceive that one of the main obstacles of which you are at present sensible to the development of either the literary or the classical studies of the University is the inferior degree of preparation which the students exhibit when they come up?—I think that is certainly a very great hinderance. I am sure when you consider that the five or six years of a boy's life, when he may be supposed to be studying (I am not speaking of his earlier years up to 10 or 11), have been spent at school, and he can only produce the miserable amount of Greek and Latin which in many cases is produced when a man first comes to college, it is impossible to say what change there might not be effected if those five or six years had been employed more profitably.

4065. Any considerable change, therefore, either in the distribution of the rewards and honours of the University, or in the curricula of studies, presupposes some considerable alteration in the public, endowed, and other schools which feed the University?—Certainly, if you would insist on a sudden and consider-



able change; yet with more prizes and rewards in the University, the subject, without any change in the schools, will, I think, gradually be more studied.

4066. My question rather tended to elicit your opinion whether, if the distribution of the honours were in any degree altered, that would not presuppose some considerable alteration in the preparation of students who come to the University?—If it were altered to any very great degree, I suppose it would presuppose such alteration with schools. It is true now not only of men who take classical honours, but honours in natural science, that many who have taken the very highest honours leave the University unable to obtain fellowships, but the reading in the University and in the schools have of course a relation one to the other.

4607. Up to this time, however, the proportion of fellowships which have been given to men who have attained honours in science is not very great?—It is very small, certainly.

4608. Consequently, if that proportion were greatly changed, the University would probably need to be aided by some preliminary preparation which should render the capacity of students for scientific studies greater than at present it is?—A great change in the University would require a great change in the school, and then I have no doubt that if the studies were more general in the schools the aptitude of boys would be soon discovered, and a boy who had an aptitude for natural science would continue when he came to the University to study the subject which had given him more pleasure than possibly (to him) dry bones of Latin and Greek had done; and thus the schools and the University would react on one another.

4069. With regard to the answer which you gave to one question which was put to you, that, in Exeter College some difficulty had been found in giving scholarships to young men who had obtained some degree of proficiency in natural science, in consequence of the abstraction of their study from other branches which is the interest of the college to pursue, do you apprehend that there might also be at present some difficulty in the general tendencies of the University in the way of the immediate adoption of any large change in the study of physical science?—There would be some difficulty without doubt; but in regard to a college the case is this: a single college has but few scholarships, it is its own interest to have for each year a good classical and a good mathematical class; so many natural science students are so many taken from the former lecture rooms; but setting such considerations aside, and these rather affect colleges than the University, it would be difficult to act against present tendencies, and adopt any sudden change, but there is a disposition gradually to give more and more prizes for that science, and its study is not now looked upon with any jealousy whatever, or at any rate with very much less jealousy than it was supposed to be at Oxford some time ago. My belief is, that if the number of students in the University who had taken high degrees in natural science were much to increase, and the professors could speak well of such students as men likely to distinguish themselves in after life, there would be, not at once, perhaps, but soon, an increase of fellowships for natural science. In all cases there is an anxiety to take those men who are likely most to distinguish themselves in life, and to do the most good in their generation; and the pressure from without also must act upon us.

4070. I understood you to refer to the natural and laudable anxiety which every college must have, that its professors and tutors should be rewarded for their exertions by the distinctions of their students, and that there was a natural reluctance to withdraw students from the most prolific source of honour?—I meant rather, that where for example only four or five scholarships were filled up in a college in a year, the scholars being ordinarily the ablest men in the college, the lecture room might suffer from the withdrawal of one or more such scholars.

4071. In the earlier part of your evidence you stated that the separate colleges could do but little in the way

of the encouragement of the study of physical science, but there was a tendency to the voluntary union of colleges?—There is such an union for the teaching of other subjects, and also I believe for the teaching of natural science. The difficulty was this: when we had a lecturer in chemistry, for example, we found perhaps that our students in natural science were giving their attention to some other subject. Now it is not likely that there should be found in any college an adequate supply of lecturers for all subjects connected with natural science, and therefore the only chance of success, as it seems to me, would be through the union of colleges for the teaching of this science; by such union three or four colleges might secure a teacher in every branch of natural science. And this union would be almost necessary for the pass-men, if there were as many as some years since. They ought to have a teacher in immediate communication with the college to look after them, and see that they do their work. With the honour men no such college supervision is necessary; they will work for the pure love of work; they know that their success in life, or their success in the University, will depend upon their work; they work with a good heart, and to them I believe that all the assistance given might be well given in direct connexion with the museum.

4072. If such professorships as are now established by the voluntary union of colleges were for the interests of the general studies of the University considered to be desirable I understood you to say that you thought that it could be brought about better by the action of some central power than by that of the colleges individually?—I referred to the teaching for natural science. The whole control over lectures in natural science should be in the hands of the professors, at least as far as the honour men are concerned; and I believe in some way by returning the fees, or otherwise colleges would be disposed to assist in the work.

4073. Did I rightly understand you to say that the professional teaching conducted by the University would rather have, in your opinion, reference to the preparation of men for honours, but that it would by no means dispense with the necessity of the daily discipline of the inferior class of students in the colleges?—I certainly think so, and I may mention one fact in corroboration of what I say. If I write to a professor to ask whether he can tell me how A. B., of Exeter College, has conducted himself during the term, the professor may feel some delicacy in giving me a reply. I have observed that one professor has changed his note to me this very term. I have now the words, "A. B. has attended my course of lectures regularly," whereas the answer I before received was, "A. B. has attended my course of lectures regularly and has worked well," or he used some expression of that kind. If the lecturer was appointed by the college I could go to him without any indelicacy, and ask, "How has A. B. worked this term?"

4074. If you supposed that the professors in the museum needed the aid of assistant professors and likewise of teachers, whom the French call *répétiteurs*, might we not conceive that the discipline in the college and the professional instruction in the museum might be associated, by the sub-professor having a duty both to the college and to the professor?—I see a difficulty still, unless the *répétiteur* were appointed or paid directly by the college; if he were, he might accompany his pupils to the museum, and if there were such an union of colleges as that to which I have referred, there might be the association also of which you speak.

4075. The Commission have it in evidence that it is desirable that for the purposes of research, and in order to induce able men, distinguished in science, to reside in the University, they should be relieved from the too great pressure of lecturing. Is that your opinion?—Decidedly so. And such a consideration has, I think, always been borne in mind by the University Council. I believe that body has always regarded the professor in two lights, both as a learner

Rev.  
J. P. Lightfoot,  
D.D.

22 Nov. 1870.



Rev.  
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D.D.

22 Nov. 1870.

and as a teacher, and that any system that would monopolise all his time in teaching, would be the greatest possible mistake.

4076. With a view to that result it has been suggested that the professor should be aided by assistant lecturers, and that also tutors connected with the colleges should keep up the discipline and study in the colleges. Would that, on the whole, meet with your approbation?—Some such arrangement might meet all objections.

4077. (*Mr. Samuelson.*) You stated just now that you think the system of teaching science is desirable and would work well in which the professors should have the aid of assistant professors, and in which the colleges, if I understand you correctly, should provide tutors; is there any difficulty in the way of a joint contribution on the part of the various colleges to a fund or funds for providing the salaries of assistant professors?—I have stated before, first, that the corporate funds go to the fellows, and, without the consent of the whole body or without new statutes, could not be devoted in any other way; and, secondly, that I do not think our tutors in the University now are so well paid that, so long as the number of classical students is what it is, we can afford to take anything off their annual payment. For tuition money must not be confounded with the fellowship revenue. A tutor is one thing and a fellow is another; the fellow has his fellowship, and he looks upon it as not necessarily connected with any teaching duty; it may be as the reward of past work, or it may be as securing him rest for his future studies. The tendency is to look more and more upon fellowship revenues as revenues to be employed for the purposes of education; but a fellow does not now so regard them. I do not think we must take into consideration what he receives as a fellow in calculating the payment that we give him as a tutor, because he is not obliged to do any tutor's work at all. How far a change is needed is another question.

4078. You think that the only fund at present available for the purpose would be the tuition fund, and that it would be only available by diverting a portion from the purposes to which it is now applied?—Precisely so; there are, however, I believe, in most colleges, fees from which it is possible that a portion might be spared. Undergraduates pay something annually towards the support of the establishment; in Exeter we call the fees establishment charges, but then what is paid is supposed to be not more than is necessary for the good management of the college under the present system.

4079. Then in fact the only available resource of the colleges, at any rate of your college, would be by the suppression or reduction of fellowships?—I do not see any other ready means if you maintain the present number and value of all the fellowships. If you were to reduce the payment of the non-residents, and they received only half what the residents received, and some five or six fellows are generally non-resident, there would be a fund at once for some other purposes.

4080. It has been stated in evidence before the Commission, that in order to make Oxford efficient as a school of science further endowments of professorships are required, do I understand you correctly as having stated that you believe that somehow or other the University would provide the funds?—I think the University or the colleges might lend some aid; but I had regard not to the endowment of new professorships when I made my statement, but to the payment of assistant teachers, teachers under the present professors, and adding to their number is a very different thing from founding new professorships. Professors would require a very different salary from the salary which would be given to a demonstrator. I do not see how the University could endow new professorships, because it has only a very small annual surplus at present, without at least imposing an additional tax upon its members; that of course is a resource, but that tax would be resorted to most unwillingly. There is at this present moment a proposal

for taxing undergraduates for a certain additional amount, but it is with the view of building larger examination schools. Whether the University will ever sanction such a scheme is very doubtful. I have heard great objections to it on the ground that each undergraduate is to be taxed an additional 1*l.* or 1*l.* 10*s.* a year; there is always a great objection to an increase of the annual payments.

4081. Then you would entirely confirm the evidence of other witnesses who stated that the amount of the funds at the disposal of the University for extending the teaching of science is very limited?—It is very small indeed for any purpose, and therefore, of course, for the one purpose that you have mentioned, and I do not see where any saving could be made. Unexpected charges constantly are arising, and it would not be safe for the University not to have some surplus.

4082. I believe you stated, did you not, that you have felt hesitation in offering scholarships for science, because you were unwilling to divert the attention of students who were full of promise from the subjects which are now more ordinarily pursued, namely, mathematics and classics?—I expressed the fact that there was an unwillingness, in which I myself have shared.

4083. Would it not be the case that if science held an equal rank in the University with classics and mathematics, seeing that the number of students of science is so small, the gain to science by the acquisition of a scholar would be held to be relatively greater than the loss to mathematics or classics?—I give my unhesitating assent to that.

4084. (*Sir J. Lubbock.*) In the earlier part of your evidence you stated as a reason for not insisting on science as a necessary qualification for a degree, that many men, even amongst those who work fairly, have great difficulty in taking the present pass degree?—Yes, I did so state. There are several subjects in which they are examined, and I know it is the fashion at Oxford, and perhaps elsewhere, to think that the requirements for a common degree are very small, and the list of the books and subjects required does not appear large, yet when you come to consider that at each examination there are perhaps six or eight papers, and that the failure in obtaining the right number of marks in any one paper causes the failure of a young man, it is not so easy after all for a pass man of perhaps less than the average ability to go through all his examinations without failure. I have always wished in our pass examinations that the *summam operis* might be more regarded so. It was all very well not to regard it, I think, at the time when Oxford could only give a degree through one portal, but now Oxford gives a degree through very many portals, as there are so many different schools, and therefore I should prefer not to insist upon the exact requirements which may be perhaps sought in each particular subject; provided there was enlarged knowledge on any one subject. If it were required that every man who passed through Oxford should know something of natural science, and supposing you had under examination a good mathematician and a good classic, and his knowledge of natural science was very small indeed, you could not but feel distressed in rejecting him if you knew that his acquirements both in classics and in mathematics were very much above the average.

4085. I am speaking, however, rather of those whose acquirements in mathematics and classics are not above the average, but who have a difficulty in taking even the existing pass degree; do you not think that some, at any rate, of those who are unable to do more than take the pass degree under existing circumstances might possibly have obtained even honours in science and have found that they had capabilities which they were not aware of so long as their attention was confined to other branches of learning?—Perhaps, if compelled to study natural science, this would be found to be the case. At the end, however, of the first year men may entirely devote themselves to natural science and take a degree; there is nothing further in classical literature required of them after their fifth term; indeed, a large number of our students do not come into



residence till their second term, so that in fact at the end of their first year of residence they may give up classics altogether, except the small portion of Greek that is required in construing the Greek testament, so that they have the option of the study of natural science now.

4086. But under the existing circumstances they are not compelled to give any attention to scientific matters, and therefore they may really have great capabilities and great talents for science, may they not, which are lying latent because they are not called at all into operation?—If a man goes into what is called the pass schools, he must now enter two such schools, and the tendency of your question leads one to imagine that you would compel every pass-man, before he offers in these schools, to attend some natural science lectures. I am not sure how that might work. Such compulsion might doubtless bring to light a taste for natural science, but how would the additional work bear upon the work now required? For every man who gets a common degree there is one failure; that is to say, taking four or five failures of the one man, and the freedom from failure of the other, I should suppose that in a man's course at Oxford for every man who takes a pass degree there is one failure. I believe I am not exaggerating in so putting the case, and I am afraid this number of failures has acted very unfavourably towards the University. When I was an undergraduate a failure was thought a very serious matter, and a man felt somewhat ashamed of himself; now, when he is only one in a very large company, he feels no shame whatever. I should be sorry to see, by any additional work, these failures increased.

4087. Mr. Pattison in his evidence gave it as his opinion that the bestowal of fellowships upon young

The witness withdrew.

NEVIL S. MASKELYNE, Esq., M.A., F.R.S., examined.

4090. (Chairman.) I believe you are Professor of Mineralogy in the University of Oxford?—Yes.

4091. Your professorship deals, does it not, both with crystallography and mineralogy?—Yes.

4092. What is your practice with regard to courses in those sciences?—Generally I have given alternate courses in crystallography and mineralogy; sometimes I have given two courses in the same term, but as a rule I have given them in alternate years. I have only one course in a year.

4093. How many students had you attending your last course on crystallography?—I am not quite sure whether it was six or seven who came to it at first, but I had five good men who went through the whole course with me.

4094. Were those students all mathematicians?—All of them were good mathematicians. I think they were all honours-men, and had taken a high class.

4095. Had they taken honours previously?—In mathematics, not in natural science. Three or four of them were bachelors who were going into the natural science school for honours in that school afterwards. They were then studying physics, and I understood that they studied crystallography chiefly with a view to its relations to physics.

4096. How many students had you in your last mineralogy course?—I had only three. There is no great demand for the subject as yet. In fact, like other sciences subsidiary to those taken into the schools, mineralogy is hardly pursued at Oxford. Geology is only very imperfectly pursued.

4097. Do you treat the subject of crystallography both with a view to mathematical and also to non-mathematical students?—That has been a great difficulty with me, because a great many men who have come at different times to my lectures, are men who have had no mathematical foundation at all; they are men who wanted a sort of smattering of the subject, for use, perhaps, for geology or for chemistry, just to have a little notion of what crystallography is, but who really never do study it in the only way in which it ought to be studied.

26060.

men for obtaining a first or second class in the classical schools is an expenditure of the funds of the University which does not produce any result in the encouragement of those studies beyond that which would be obtained by the honour of the degree alone, and he thinks that we should have exactly the same amount both in quality and quantity of studies if we had none of those fellowships. Is that your view?—I should be very sorry to put my opinion in opposition to that of Mr. Pattison, who has studied the matter much more fully than I have done, but I think that if you were to take away the University rewards you would take away that which offers a very great stimulus to many of our men. I can hardly conceive that it should not be so. I know that young men at college talk of a fellowship as a very great prize, and look forward to it as a great distinction, and it is a great aid to them in early life.

4088. (Chairman.) I think you stated early in your evidence that the number of science students is much less now than it was some years ago; does that remark apply to those who take honours, or only to pass-men?—Only to pass-men. I should think there are as many who take honours. Last year there were a very large number who obtained honours, but certainly the number examined for the common degree is very much diminished.

4089. Are your scholarships given to students in the University at large, or only to students of your own college?—To the University at large; indeed, a candidate need not be a member of the University. We should be very happy to receive any candidates from Cambridge, and we have had them for fellowships, but never for scholarships. I see in the notice from Trinity College that the scholarships are thrown open, and an Oxford man may compete for them.

4098. As a matter of fact, are your lectures such that they can be understood by men who are not acquainted with mathematics?—In the last courses that I have given they have not been, but I have had courses on the subject in which men came to me who were mathematicians, and who wanted to have a mathematical training in crystallography, whereas other men came and brought no mathematics with them. It was obviously impossible to lecture to both, so what I did was, to take the men separately, and I used to take two or three at a time and work them in the subject; but it is a most unsatisfactory thing to have to teach physical science to men who have never studied mathematics at all.

4099. Do you consider that mathematical men are those with whom you have mainly to do?—I do, in crystallography.

4100. Do you consider crystallography to be of importance to chemists as well as to geologists?—Certainly for physicists, for chemists, and for geologists, I consider it to be an essential part of what ought to be their education. I know a great number of geologists, and a great many chemists, who know nothing thoroughly about it: in fact, I have heard some curious mistakes in the lectures of very illustrious professors of chemistry before now, simply and entirely from a want of knowledge of this subject; but it is not a difficult science, and it is a great pity that it is not more studied by persons to whom it is really an essential part of their education.

4101. A moderate amount of mathematics is in your opinion sufficient?—Yes, very little indeed; you want little more than plane and spherical trigonometry, and a little analytical and ordinary geometry.

4102. Geometry of three dimensions, I presume?—Yes, certainly.

4103. Do you consider that the science of crystallography is at a low ebb in this country?—I think it is at the very lowest ebb. We have the greatest crystallographer of our day, I may say, at Cambridge. Professor Miller was, in fact, the founder almost of modern crystallography; his system is by far the most

Rev.  
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D.D.

22 Nov. 1870.

N. S. Maske-  
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22 Nov. 1870.

beautiful and elegant that has yet been given, or probably ever will be given, to the world for crystallography. If I except him, and perhaps a few of his own pupils in Cambridge, there are very few persons in England who would know how to set about the ordinary calculations requisite for determining a crystal.

4104. Is that the case also on the continent?—No; the subject is very much more studied. In Germany, in particular, it is very much more studied.

4105. What do you consider to be the principal causes of the low state of these sciences in England?—I think the principal one is to be looked for in the very basis of our scientific education. It is the fact, that people in England do not feel, in the first place, that scientific education is at all necessary, and, in the second place, they do not feel that at the foundation of a scientific education must lie a mathematical training. That seems to me to be the fundamental cause of it. Then, consider the line which we will say a chemist or a geologist follows when he takes up his science: he too often rushes at once into a science like chemistry or geology. In geology, for instance, he begins, perhaps, with a certain amount of physiological knowledge, but he does not feel, and has never been taught to feel, that at the bottom of either chemistry or geology, there are certain great branches of the science of physics, and crystallography amongst their number, which are really necessary to the proper pursuit of either of these sciences at all.

4106. Can you suggest any remedy for this state of things as regards this particular science?—What I think would be a desirable plan would be this. At the Universities I should connect crystallography with the teaching in the schools. Where men take in either of the subjects that I have mentioned, I should certainly connect crystallography, as a necessary study, with their education. I should not allow a man, for instance, to take in a subject like light, viewed as a branch of physics, unless he understood what you meant by the directions in a crystal, and the different sorts of symmetry characteristic of crystals. Unless he could understand that, I do not see how he could ever study the subject at all completely. And the same with chemistry: unless a man is not only acquainted with the principles of crystallography, merely as geometrical principles, but with something of the theories that have been started to explain the structure of a crystal, I do not think that he is in the same position for grappling with questions, like those great questions of molecular chemistry which are at present agitating the minds of chemists, as he would be if he possessed that knowledge. I think that in reading what chemists write, one feels very much the want of that sort of knowledge and that sort of training.

4107. You would allow no one to take honours in such a subject as heat, or as chemistry, without a knowledge of crystallography?—That is my view.

4108. Have you any suggestions to make with regard to granting scholarships and fellowships as prizes for the study of crystallography?—In what I have hinted about that in the précis of my evidence, I have, in that respect, included crystallography with other sciences. It perhaps would have been better if I had left crystallography on one side. On the supposition that crystallography was really made a part of the education of men who went in for physics and for chemistry, I would not say that it was necessary, however desirable, to have special scholarships and fellowships for that particular subject; but with regard to the other branch of my professorship, for mineralogy, for sciences which, as classificatory sciences, are akin to mineralogy, I think what I have said is perfectly true, and that the right and only way of encouraging those sciences in the University would be not so much to make them subjects for the schools, as to view them as distinct subjects for which the University should offer special rewards, somewhat in the character of the present mathematical scholarships, or the sanscrit scholarships, and the law scholarships. These deal with subjects that are a little on one side of or beyond the

regular systematic lines of study in the place, and by their means a very healthy kind of stimulus is offered to men to turn their minds in a particular direction. It does not divert a man from his other work much, whilst at the same time it makes him master of a subject for which we want masters in the University. I think it would be a very good way of encouraging different subjects like mineralogy, botany, and geology, if that were done. I would certainly exclude those three special subjects from the necessary matter of the schools; and as to zoology, viewed apart from physiological questions, I would consider that also as a subject which would be best encouraged in the University in that way.

4109. Will you have the goodness to specify the exact nature of the fellowships which you would propose to be awarded for proficiency in these subjects?—When one comes to discuss these sort of questions, one is only arguing on rather theoretical grounds; but one is conscious of being in Oxford in the presence of a very vast amount of wealth which was really intended for, and which all the country recognises as being wealth that ought to be devoted to, educational purposes, and one does feel that a very vast amount of that wealth is wasted, and that if proper means were taken to direct it into the right channels we should not have any questions about where we should have to go for the means of finding such encouragement as I have been speaking of. It is very easy to point out colleges, in particular, where they have ample funds to provide scholarships and fellowships of the kind that I have been speaking of.

4110. Are the fellowships that you contemplate to be connected with work at the University?—I think that that is a very important point. I remember that many years ago I tried to get, upon a somewhat different footing from what it had been given before, a travelling fellowship, and one of the conditions I remember on which that travelling fellowship was then to be held was that the travelling fellow was expected to send home something like a sketch of the results of his travels, and of what he had really acquired or done, by way of showing that he had used the fellowship wisely and properly. I think we might have something very much of that kind in the sort of scholarships and professorships that I am proposing. Suppose the fellowship were to be held for three years: if at the end of that period the fellow could satisfy the board, or whatever persons were the representatives of the University in the election, that during the time he had held it he had really carried forward the subject, or that he had himself acquired a larger and more comprehensive knowledge of it, I think in that case it would be a very wise provision that the fellowship should be extended again for a further term of years. But I think that to give a man a fellowship for a long term, such as, for instance, five years, because to-day he should pass a good examination in a particular subject, would not be giving the sort of encouragement that we want. I think the other would be a far better way of utilizing the means that might be at our disposal.

4111. You would allow him to hold a fellowship for three years as a reward for his knowledge?—Yes. I would say that it would be a reward to a man that he should receive a fellowship or a scholarship for a certain time, and that during that time he would be, for instance, a mineralogical fellow or a botanical fellow; and I would expect that at the end of that time he would have made himself a much greater proficient in his subject, and, possibly, if he is a man of any originality, he would have added something to our knowledge of it, and in that case I think he would be a worthy person for the honour and emolument to be extended to for a greater length of time.

4112. Would you or would you not make it a condition of his fellowship that he should assist the professor in any way?—I think that might be a very useful occupation for him. In fact, it would be one of the ways in which, in all probability, he would work with a view to doing the very thing I have been speaking of.



If he did that, and if he did his work well, it might be considered as evidence that he had not wasted the opportunity given him. In fact, assistance of that kind is exceedingly wanted for the teaching of the sciences.

4113. Do you think that so far as those studies are pursued the professorships of mineralogy at Oxford and Cambridge illustrate the advantages of encouraging subjects of this kind?—Yes, for this reason: I have held the professorship now for a great many years, but I remember at one period there was some discussion in Oxford about the usefulness of having a professorship, for instance, of mineralogy, owing to the professor after I left Oxford having always a very small class, and there is a great deal of reason in that point of view; but if you look at those professorships, the professorship at Oxford and the professorship at Cambridge, which are really but very little more than honorary things, for the stipend to both of them is very small, you can point to men who have done a great deal of good work, and whose work has been due very much to the fact of their having held that position of responsibility. In the case of Professor Miller, of whom I spoke just now, I do not mean to say but what he would have written a book on crystallography, but I believe that the invaluable book which he did write on the subject was very much the result of his being identified with it by the professorship at Cambridge. Dr. Whewell, also, was for a short time the Professor of Mineralogy at Cambridge; and during that time, I think it was, that he wrote a paper in the Cambridge Philosophical Society's *Transactions*, which certainly was a most remarkable paper, containing the germs of the method that Professor Miller afterwards published. I can, therefore, only say that those two men in Cambridge, at any rate, have done their duty by England and by the subject they represented. Then, in Oxford, previous to myself, there was Dr. Buckland, who was, in his earlier years, retained in Oxford, I believe, solely by the little honour attached to his being Professor of Mineralogy. The professorship of Geology was subsequently added by the Crown, to increase the stipend, but at the time when he first started in Oxford as a student in these subjects, and was made Professor of Mineralogy, he had succeeded Dr. Kidd, who had published books on mineralogy, and represented this science with considerable industry in his time; so that those professors, even though they might have been enabled to do very little in the form of actual teaching of mineralogy, have given, I think, a good account of their appointments. I think if one could introduce crystallography (and, indeed, I may say it is now beginning to be so introduced at my own University), so as to make it more a part of the scientific education at the Universities, those professorships would fill an important place.

4114. It has been proposed, has it not, that a chair of mineralogy at Oxford should be endowed by Magdalen College?—Yes; it was one of the ordinances of the Parliamentary Commission for regulating the relations of the colleges to the University, that certain professorships were to be founded at Magdalen; two of them have been founded, and two others (one of which was to be a mineralogical chair) ultimately were to be, but unfortunately, as regards this question, almost all the decisions of that Commission depended on, or were left to the action of, the colleges themselves. The colleges had more or less of free play allowed them, and Magdalen had the opportunity, after founding two of those professorships, of devoting her funds either to founding more professorships, or to the naturally more attractive mode of spending it—the improvement of the college itself. The consequence is, that they have postponed the University professorships to the college interests, and I do not know when those two professorships are likely to be founded.

4115. The plan is not altogether abandoned?—No, they could not abandon it. They are bound to do it at some future day, but I believe that the day has been indefinitely postponed.

4116. In your opinion, is mineralogy an important

member of the classificatory sciences?—Yes, speaking from an academical point of view, I should say that. Of course it has other bearings which have nothing to do with its classificatory character, but viewed philosophically, and in its relation to the logic of science generally, I think that is its great claim to recognition in a University; in fact I would prefer to treat it as a classificatory department of inorganic chemistry.

4117. Do you think that geologists ought to be acquainted with mineralogy?—I think that stands to reason; but unfortunately they rarely are so in a proper sense of the word. Palæontology now has almost usurped the name of geology. Geology is an historical science; it is a branch of history, in fact; and, if you can invest palæontology with a little historical character, you make it geological. But that is not at all an exhaustive definition of geological science. In fact, the geology that ignores, or is not familiar with, the actual constitution and chemistry of rocks, can hardly be called geology in the complete sense of the word; and, of course, mineralogy is the key to that part of the subject.

4118. What would you say was its special character as distinct from classificatory chemistry?—I think its relation to the mining industry may be said to be its chief distinction. In fact, if it were not for its relation to mining industry, it would have been absorbed into inorganic chemistry; for it would be the classificatory part of inorganic chemistry. I mean that that is so in my own opinion, looking on it from a larger point of view than that of its being a science which deals with classifying minerals only, or discriminating between minerals, meaning by minerals chemical compounds which are found in the crust of the earth.

4119. Are mineralogy, botany, and zoology, in your opinion, subjects not well adapted for the schools?—They are not; meaning by schools, schools at the University, academical schools, schools of examination.

4120. What is it that renders them ill adapted for the schools?—I do not think that any classificatory science, pure and simple, as a classificatory science, presents the solid educational elements that are presented by a science in which you have methods of reasoning, like those which mathematics or chemistry introduces. Of course they are very important in relation to logic and, so far, as exercises in reasoning, and it is very important that there should be persons in the University who understand those sciences; but, really, so far as regards actually creating men of science and giving them a proper education, that sort of fundamental education which should fit them to take their part in the world as men of science, anywhere and in any department, I do not think that for that the classificatory sciences can be viewed as an essential part of education. You can make of them the most valuable means of education for the faculties of observation while those faculties are keenest and are growing in early life; and later on you may give them a high place in your educational system by implanting them on a scholastic scientific training, but if in the interim you introduce them as educational subjects, you do so, or you must be supposed to do so, to the exclusion of something else; and I think it would be a pity to exclude anything which was involved in the exact philosophical treatment of the grammar of a subject like chemistry or physiology or physics for the sake of substituting a merely classificatory science in its place. I do not mean to say a word in depreciation of those fascinating sciences, because I think that they are extremely valuable; but then I speak of them from another point of view than that of an academical education.

4121. You would encourage the classificatory sciences by giving scholarships in them to men who had taken up other subjects in the schools?—Yes. I would not allow Oxford to put her seal upon a man as an educated scientific man who had not got something more than a knowledge of a classificatory science: that is to say, I should conceive that, unless he had first of all exhibited a knowledge of the

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22 Nov. 1870.



N. S. Maskelyne, Esq.,  
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22 Nov. 1870.

sciences upon which, in fact, the classificatory sciences rest, he was not a person to be recognised by the University as an accomplished man of science.

4122. What sciences do you think are the proper subjects for a science school?—It is an old subject with which I had a good deal to do many years ago when I was living in Oxford. I had then a good deal to do with the framing of the present school, and I think the general outline of our school as framed then was a good one—the outline I mean which embraced physics, physiology, and chemistry: meaning by physics, of course, all the different branches of experimental philosophy. Those were the three subjects that we recognised then, and I would certainly add now, what I always pressed for then, and which I unfortunately did not succeed in introducing into the schools in those days, that is, a certain minimum of mathematical accomplishment at starting. I think that is an essential which I would demand from every man who went into that school; even, I would say, from physiologists, though that is a more open question.

4123. Can they take honours in the natural science school now without any mathematics?—I believe entirely without.

4124. Practically, are they able to take honours without any training in mathematics?—Yes; a man might take in, for instance, the minimum of physics, which ought not to imply his being able to leave out mathematics; but I remember when I myself was examiner some years ago that was the case. I do not know how far it has been altered since. I cannot speak for the present state of the school, for I have had nothing to do with the examinations for some years, but I know it was so in those days. Of course a man may take in a very little indeed to acquire the minimum of physics, and then he can devote the rest of his energies to either chemistry or physiology.

4125. Are you speaking now of pass-men or of men who take honours?—I speak of men who go into the school at the present moment. I believe that pass-men in that school are very few.

4126. What is your view as to a science line being imperative at Oxford?—I think that there ought to be a science line in the University in which a man can take honours, and such that he is not obliged to take in any other subject after a certain period in his career; and at that certain period in his career he should be emancipated from other work, so that he may then devote himself entirely to natural science.

4127. But you would at some period of his education require him, would you not, to go to you and show that he possesses some literary attainments?—Yes. I will not say whether it should be at a matriculation examination, or at a "little go" examination, or at what point in his career, but my own impression is, that the earlier you can emancipate him from other work, the more you can throw upon the public schools, and other schools, the onus of sending a man up properly prepared in certain fundamental points for Oxford, and for the school in question, the higher will be the character of the physical science school that you will be able to establish.

4128. What would you consider the fundamental subjects to be required from all?—I should not limit them to certain special particular subjects, but should give a choice amongst certain subjects. On the other hand, I presume that we are hardly prepared to do away with the knowledge of a classical language. I myself would prefer, for instance, to see Latin done away with in preference to Greek, because I think Greek is a language which is a great deal more educational, and a nobler language; but, on the other hand, I know that is a feeling which other people do not share with me, and it is not likely that that will ever be done; but I would certainly say that one of those languages ought more or less to be a subject that a student should have acquainted himself with before he came to Oxford. Whether you should teach him any Latin or any Greek at Oxford is only a question whether you will teach it him in the first year, or not teach it him

at all; I mean as a compulsory study. It would not interfere the least in the world with the natural bent of the University towards its classical education, and I do not believe that you would take five per cent. of the men out of that school; I believe that you would draw to Oxford an entirely new class of men by the sort of school that I have been speaking of.

4129. (*Professor Stokes.*) You have proposed that there should be certain fellowships awarded for special sciences which cannot well come in in connexion with the schools, and you have mentioned mineralogy and botany; are the Commission to understand that the persons who would be elected to such fellowships shall have passed some general examinations first?—Yes, I think so.

4130. And then be examined in those special subjects?—Yes, I think so: that is my idea. It is a thing for which you would have to draw up a scheme; you cannot say until you look at the matter from all points of view whether it would be desirable to have scholarships. I purposely said scholarships and fellowships, because I supposed that it might be considered advisable to give to men who had not yet taken their degrees, a scholarship in subjects of that kind; men who had made less advance in the subjects than the candidates for fellowships, but I would rather guard myself against, at present, being very positive upon that point. My own impression certainly is to make them extra honour subjects, if I may use the expression; subjects after men have taken some honour, or in some way or other evidenced their acquaintance with the fundamental subjects of the school.

4131. In what way would you regulate the election to such fellowships: would you propose on one occasion a fellowship to be given at a competitive examination for the subject of mineralogy, and on another occasion for the subject of botany, for instance; or would you propose to have certain fellowships which might be given for one of those subjects when it was known that there was a man who was doing real good work in them?—I think that the latter would be by far the best method. Still, I should be sorry to allow that either subject should ever be quite excluded; I would have one or more fellowships or scholarships for each of those subjects, fixedly for the subjects, and if no man came up to the standard I would not give him a fellowship. On the other hand, I think there should be, besides, a considerable number, some six or eight, or ten perhaps, fellowships that would be given in the way you mention. At one time, perhaps, one subject is of more importance than another, and much greater progress is made, and men's minds are more directed to it, and it would be advisable to have two or three botanical fellowships, and one, perhaps, of mineralogy, or at another time two or three of mineralogy and one for botany; but I would leave the thing elastic, and the University, either by statute or by delegacy, probably by the latter, would be able to determine in what way those fellowships should be given. The only thing that I do consider very important is, that such fellowships should be set apart especially for that class of subjects.

4132. (*Sir J. Lubbock.*) Do I rightly understand you to say that you think that mineralogy, zoology, and botany should not form a part of the University general system of education?—I do not exclude them from the education, because I should still have professors in those subjects. I would still have men who would be rewarded for taking them up; but what I have said is, that I do not think that a man ought to be able to take honours, for instance, in botany, zoology, or geology, or in mineralogy, unless that class means that he had taken up before a full and requisite amount of those which I consider fundamental subjects, with which our schools deal, namely, first of all, a certain basis of mathematics, and then on that either physics, or physiology, or chemistry; chemistry involving a certain amount of physics, and physiology involving a certain amount of physics also. A man ought to be master of the subjects that are fundamental to that extraneous science before he is allowed to take honours in it; for instance, a botanist without any knowledge



of vegetable physiology, or a chemist without a proper knowledge of crystallography, hydrostatics, heat, or magnetism, and subjects of that kind, I conceive to be not a complete botanist or chemist at all.

4133. Fully admitting that, do you not think that the education which entirely neglected such important branches of science as those which we are now discussing would be very incomplete in its character?—I should not completely omit them, but I think that you will know a great many scientific men of very great eminence, and persons who are in the highest sense of the word scientific men, who probably may never have studied one of those classificatory sciences properly, or even at all. It seems to me that they are subjects specially adapted for the study of men who have made themselves already more or less masters of the subjects which lie at the root of them, and that then they carry on their education into a new science in botany, or mineralogy, or geology. I do not think that you can call them educational subjects if you separate them from the sciences which lie at their root, and I do not consider that I am eliminating them from the academical system when I say that you should not consider that any man could take them in as an honour subject without having underneath them that fundamental knowledge which is requisite for their being properly studied at all.

4134. No doubt there are many cases in which a man attains very great eminence in one branch of science, but is very ignorant of science generally; but that is hardly a type which one wishes to see encouraged?—I want to encourage these sciences, but I think that you are demanding too much of a man if you say that he must take in, for instance, botany, or mineralogy, or zoology, or any one of the departments of zoology, and then say that he must take that in besides the solid work which lies at the basis of that school. I would rather encourage a man to take in those more solid, and, on the whole, more fundamental subjects, and then encourage him afterwards to pursue the more fascinating sciences in the wake of these. That is what I mean; I should not eliminate them. I want to introduce them, but I think the right way to encourage them is to postpone their study, to a certain degree, to what I conceive to be the more fundamental and important branches of scientific study.

4135. It is one thing to postpone a study and make it subsidiary to another, but it is quite a different thing to omit it altogether, and I understand you to say that you would omit those sciences altogether as not being well adapted to the schools, although in cases where students chose to take them up voluntarily, you would be prepared to give them some rewards. What I want to understand from you is, whether you would make them subsidiary to the other studies which you regard as more fundamental, or whether you would omit them altogether as part of the general education of the University, merely admitting them as studies which are to be rewarded in those cases in which any individual student cares to take them up?—As I think I said before, I should not object to their being taken into the schools, but I should only allow them to be taken into the schools as additions to the fundamental sciences which I have spoken of. I would not allow a man to take in mineralogy who had not made himself thorough master, for instance, of inorganic chemistry and crystallography, which subjects I should insist upon before I should look at his powers as a mineralogical man; and so with botany and the various branches of zoology, one can easily point to sciences which a man must be equally familiar with before you can allow him to take them in. I should have no objection then to his taking them into the school and letting them have their value there, but I think you are doing more for those sciences when you appoint for them the special rewards of scholarships and fellowships which shall be hailed as special rewards for them. For a man to be called, for instance, the senior mineralogical

fellow, or the senior botanical fellow, would be held in the University to be not only a substantial but a very rich reward. That, I think, is not omitting them altogether from our curriculum; it is recognising other rewards than those of the schools, and other conditions than those which are simply conferred by a class as rewards and distinctions which are part of the education as it exists now. Sanscrit is only taken in in that way, and Sanscrit is considerably studied in Oxford; and you may say the same of the Vinerian Law Fellowships, which are held in the same way I believe.

4136. Sanscrit is no part of the general course, is it?—No. Sanscrit is no part of the general course, but there is no reason why it should not be.

4137. Then I understand that you would introduce those sciences into the schools?—I would allow them to be introduced into the schools, but I would not attach to them the same kind of value that I should attach to, for instance, a man who took in physical optics. I should not consider that a man who took in physical optics stood upon the same level as a man who took in botany. I should consider that the one was more connected with the fundamental branches of education which is the business of the school to represent than the other; and the other I should consider would be better rewarded as an after subject for a man who, for instance, had had time to go about and study botany largely in different countries and at home, and perhaps formed collections and so on, and had been able really to do something for the science; but I do not think that an undergraduate at 19 or 20 has really had or can have had an opportunity of doing it thoroughly well.

4138. But in granting a degree, would you introduce botany as one of the subjects of examination?—I would allow a man to take it in as a subject for examination; I would have botany to be a voluntary subject, but I would not allow any honours for it, except to a man who had studied the other subjects, and had got the fundamental education which I conceive to be at the root of botany.

4139. Mr. Jowett, in his evidence given before the Commission the other day, drew a distinction between the preliminary education, which ought to be general, and the subsequent education, which ought to be special. Do you consider that any man could be said to be thoroughly well educated according to the system which we hope to see established who was left entirely ignorant of such important subjects as mineralogy, botany, and zoology?—I should certainly consider them much more to be desirable subjects for after pursuit than for the actual University career. They could form part still of a man's career, because the opportunities the University would offer him for acquiring fresh knowledge, or for utilizing the knowledge he had acquired, on achieving a fellowship would probably be sufficient to induce him to reside at Oxford for a certain time. You might attach duties to the holding of a fellowship which would still link him with the place, and it would still be more or less a part of his University training.

4140. You are now speaking of the studies which come at the end of the general training?—Yes, I am certainly in that case. If this science line succeeds, the only thing that you have to do is to extend the principle, and I think you might extend the principle very largely.

4141. I wished to understand how far you would extend the principle, and I had understood you to say that you thought it was not desirable to extend the principle so far as what you call the classificatory sciences as a branch of the general training of the University, but rather to make it the subject of special rewards, which, of course, would only tempt a special class of students?—What I mean is, that I would extend the principle of those special rewards to subjects of that class in the University, which I hold to be more or less on one side of the subjects studied as the fundamental subject of the school. I should say that for those things you could

N. S. Muske-  
lyne, Esq.,  
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22 Nov. 1870.



N. S. Muske-  
lyne, Esq.,  
M.A., F.R.S.

22 Nov. 1870.

extend and increase the number of rewards very considerably; you can make it worth a very great many men's while, instead of one or two, to work at botany or mineralogy; but what I do not see at present is, how in the amount of time that a man has for getting up his work for the final science school he would have time to do it properly in the fundamental subjects, while he was taking up what I would call very technical subjects like these, which would rather draw him away from the stricter and sterner work which he had before him. Of course if he had time for both, as I said before, let him take in botany or mineralogy into the school as extra subjects, and let him have a reward for it, and let it be counted in his class, provided he has taken up a sufficient amount of those other subjects which I hold to be fundamental.

4142. Do you conceive it possible to have any sound knowledge of physiology without having some acquaintance with zoology?—It is a subject on which I would rather leave a zoologist to speak, but I should have thought that physiology was fundamental to zoology, though of course the amount of knowledge that a man

would get in zoology in studying physiology would be considerable; but it would be zoology as a classificatory subject complete in itself; I mean not studied from that point of view so much as from a physiological point of view.

4143. You would introduce zoology, but you would have it studied from the physiological side?—I am speaking only of this subject as a classificatory science, and I am speaking of mineralogy as a classificatory science. A chemist lecturing on chemistry must introduce now and then the ores of metals; you may say that he then introduces mineralogy which it is not. The description of the ore of a metal falls certainly within the scope of an inorganic chemist's work, but you are not discussing the subject of the ore of metal then in its relation to other minerals; but it is in its relation to other minerals, and the character of mineralogy as a classificatory science that I draw the line between allusions to mineralogy in a chemist's lecture and the teaching of mineralogy as a classificatory science.

The witness withdrew.

Adjourned to to-morrow at half-past 11 o'clock.

No. 6, Old Palace Yard, Westminster, Wednesday, 23rd November 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

The Very Rev. HENRY GEORGE LIDDELL, D.D., examined.

Very Rev.  
H. G. Liddell,  
D.D.

23 Nov. 1870.

4144. (*Chairman.*) You are the Dean of Christ Church and Vice-Chancellor of the University of Oxford?—I am.

4145. You have at Christ Church a special endowment applicable in part to natural science?—Yes, Dr. Lee's foundation.

4146. That has now increased considerably in value?—Very much.

4147. The income is now, we understand, about 2,600*l.* a year?—Yes.

4148. Is not somewhat more than half the income of the foundation now applied in promoting science?—Yes. In the paper which I have furnished to the Commission [see Appendix] I have stated the proportions in which it is applied. I should say that the present application of the remaining half is merely a temporary application, provided for meeting the difficulty of adjusting the new system to the old. That difficulty is now rapidly disappearing, and when it disappears the greater part, if not the whole, will be applicable, if required, to the purposes of science.

4149. You have now three readers in anatomy, chemistry, and physics respectively, whose salaries are chiefly provided from this fund?—Yes. Their present salaries are 300*l.* a year each, and they have further grants from the general tutorial fund, collected from the young men, which are stated in the paper I have sent to the Commission.

4150. Are the mathematical teachers paid out of the same fund?—Yes, they receive a certain amount.

4151. Are those the ordinary mathematical tutors of the college, or are they a separate class of teachers?—No, there is no separate class; their payments represent part of the fund devoted to teaching mathematics. The money devoted to mathematical teaching from the tutorial fund is divided in certain proportions among them.

4152. Do the readers in anatomy, chemistry, and

physics act in concert with the University professors in the same branches of knowledge?—Yes.

4153. Are they under their direction in any respect?—No, not distinctly; they need not be at all, but by arrangement they act with them entirely. Mr. Reinold, the Teacher of Physics, for instance, is employed by Mr. Clifton, the Professor of Physics at the Hyde Institute, as demonstrator. But at any time Christ Church has the power to require his entire services.

4154. Does he do that work in addition to what he does as reader in physics at Christ Church?—Yes; at the same time part of that work supplies the place of what he might otherwise have to do at Christ Church; the Christ Church men, as they require more advanced teaching in physics, will go up to him there. The number of students being small, it would be throwing away time and labour for him to give the same lectures in two places.

4155. And do the same remarks apply to the readers in anatomy and chemistry to any extent?—In anatomy to a considerable extent; in fact more so than to the other, because he has a *locus standi* in the museum; he has a room there. The bulk of the University collections belong to Christ Church, and they are deposited in the University Museum for the use of the students generally.

4156. Are they a loan from Christ Church to the University?—Yes. The chemical reader, on the other hand, does not lecture at the museum as Lee's Reader; his teaching is in Christ Church.

4157. Have you a building used as a chemical laboratory at Christ Church?—We have.

4158. And have you also one for the purposes of a physical laboratory?—No, we have not. That reader has a room in which he teaches the elementary subjects, and a small library; but for the more advanced parts there is a noble institution provided for the University lately out of the profits of Lord Clarendon's



History, and that is at present, I believe, sufficient to receive all the students from all parts of the University. But if the Hyde Institute be required for University teaching exclusively, and if our pupils in physics increase in number, we shall, I doubt not, at once proceed to make arrangements for enabling our reader to lecture in Christ Church.

4159. Are the lectures given by the readers open to all members of the University?—Yes.

4160. They are not confined to Christ Church?—No.

4161. Do any considerable number of young men attend the lectures of any of your readers?—No, the number is not very large.

4162. Are they generally men who are going out in honours?—All of them, I think.

4163. Is the number increasing, or stationary, or otherwise, at present?—It is increasing in the University considerably. Professor Phillips has shown me a list of the students who are at work in the museum, and he states that the increase is considerable.

4164. But a certain number work with your readers, do they not, who are not in any way connected with the museum?—They all go to the museum also, I think, finally, if not at first. They may have their instruction solely with us, but they go to the museum also; they generally attend lectures in our building and also at the museum at the same time.

4165. As a rule, are the lectures delivered by your readers of a more elementary character than those provided at the museum?—The general lectures are so, I believe. But for instruction in practical chemistry none of our young men need go to the museum. In physics, probably it will always be desirable that the pupils should go to the Hyde Institute, for the sake of seeing and using the expensive and elaborate instruments which we shall not be able to possess. The Physiological Reader, as I have stated in my written evidence, is at present stationed in the University museum.

4166. You award, do you not, a certain number of your junior studentships for proficiency in physical science?—Yes, we are bound under the Act of Parliament to do so.

4167. The junior studentships at Christ Church correspond to what are commonly called scholarships in other colleges?—Precisely.

4168. What is the proportion of studentships awarded for science?—This is an extract from the Act: "In elections to one in every three open junior studentships the subjects of competitive examination shall be alternately mathematics and physical science." That is the minimum required.

4169. You have at Christ Church 30 open junior studentships?—That is the number at present.

4170. You state in your letter, "On the 1st of January 1870, out of 30 open junior studentships there were five mathematical, and five in physical science"?—That was the exact number at that time. The full number is to be 31, besides 21 set apart for boys elected from Westminster School.

4171. Is the number of competitors for studentships in physical science large?—Not large.

4172. Have you been able to award the proportion hitherto?—Yes. At the last election in last March we awarded two, where we need only have awarded one.

4173. Hitherto, have candidates presented themselves possessing an adequate knowledge of physical science?—We have always had one good candidate at least. We have generally on the average about five, but some of them certainly have very little claim to be candidates.

4174. What prospect is there, in your opinion, of the study of science becoming more general either in Christ Church or in the University generally?—We offer those studentships to free competition every year, and the number that come, as I say, is small in comparison with the candidates for other student-

ships,\* and some of them are not what one would call up to the mark. Several of them certainly are not the sort of men that we wish to have members of the college at all, and I do not know what reason one has to expect an increase. We have had this going on for several years now, and unless an alteration is made in our schools, or in the elementary education of the country, I do not see what we can do to increase it; for the prizes that we do offer are not competed for considerably.

4175. Do you consider it probable that the small number of candidates who present themselves is to be attributed in any great degree to a deficiency in the elementary education at the schools?—I presume that if the schools devoted themselves more to teaching these subjects, there would be more candidates. We have had few candidates from the great public schools.

4176. Do you think that young men or boys prefer classical to scientific studies?—I can scarcely answer that question. Perhaps, where scientific studies are taught in the severe manner in which they are now being taught in the University, it is very doubtful whether they would prefer the scientific to the classical. If it is merely a science of observation, botany and so on, which they can learn partly as an intellectual amusement, they probably might, but if it is to be studied in a severe manner with a mathematical foundation, I should doubt it.

4177. Do you think that there would always be a larger number applying themselves to classics?—I should be sorry to prophesy.

4178. Are you prepared to recommend any steps which the college or the University might adopt to give greater encouragement to young men to pursue the study of science?—Nothing more than an enlargement of the means which they are at present applying, if the demand arises; but as far as I can see at present the supply is equal to the demand, if not superior. If the demand arises, I think we should enlarge upon the foundations that we have already laid. I am not able to suggest anything new in kind.

4179. Do you award any of your senior studentships for scientific eminence?—Not hitherto. Those three Readers are in fact Students, and they are classed so under the Act; and if the demand for such education increased we should no doubt immediately increase the number of such Students, but at present I think they are more than sufficient for what is wanted.

4180. You have no other senior studentships which have been awarded for scientific attainment?—No; the fact is, that at present the senior students are very limited in number, owing to the difficulty of adjusting the old to the new constitution. It is all we can do to get tutors to supply the ordinary need of the college; we have had no opportunity really of supplying anything but what is actually wanted.

4181. Are all your senior students resident in the college?—Nearly all; all are resident in Oxford but one of those who have been elected of late years.

4182. And all employed in college work?—All but one. We have elected actually for that purpose always of late, and we are obliged to do so; but of those who were elected some time ago, some of them have ceased to teach, and some of them were elected before the pressure arose, and they are not resident.

4183. What are your views as to the degree in which it is desirable that literary and scientific studies should be united—are you of opinion that all students should be required to possess a certain amount both of literary and scientific knowledge?—I really do not feel myself able to give an opinion that is worth having upon that subject. I think with regard to men who are not reading for honours it would be most desirable indeed that they should be required to

\* I ought, rather, to have said, that, though the average number of candidates for all Studentships probably is much the same, yet, as the number of Studentships for Physical Science Scholarships given throughout all the colleges is extremely small, one would expect the number of candidates for each to be much larger than in other cases; but they are not so.

Very Rev.  
H. G. Liddell,  
D.D.

23 Nov. 1870.



Very Rev.  
H. G. Liddell,  
D.D.  
23 Nov. 1870.

show some knowledge in both; but with regard to those who are reading for honours, and trying to make themselves perfect in one branch of learning, I feel doubtful whether it would be desirable to force them to attempt more than one subject, much less a number of different subjects.

4184. You would like to see the pass-men obliged to exhibit a certain amount of knowledge both of literature and science?—Yes, I have given evidence of that in advocating the introduction of University statutes to produce that result.

4185. That is not the case at Oxford at present, I believe?—No.

4186. You have had an opportunity of reading the evidence given by Dr. Acland before this Commission, and may I ask you whether you generally agree with his views?—Yes, I think I generally agree with them.

4187. Suggestions have, I believe, been thrown out that a certain proportion of the fellowships might be suppressed with a view to encourage University teaching on a larger scale. At Christ Church we understand, from what you have already stated, you have not a larger number of studentships than are required for the college business?—Not at present.

4188. What is your view on the general question as to whether in any case it would be desirable to suppress college fellowships for the purpose of increasing the University staff?—I think that involves a plan for complete University reform of a very extensive kind. The question of whether fellowships should be permanent as they are now, or held for a term of years, whether they should be given as prizes for past exertion, or only for purposes of teaching; or, again, whether they shall be divided into two classes—one class temporary for prizes, the other class, permanent, for teaching, I think are points well worth considering.

4189. If you have considered those points we should be very glad to know your opinion respecting them?—I stated in the evidence which I gave before Mr. Ewart's committee, in the House of Commons, on the question of University education some two or three years ago, that I thought it would be desirable to retain a certain number of fellowships as prizes for the encouragement of proficiency and to stimulate study, but that those fellowships should terminate in the course of seven or ten years, and then that the rest of the income of the colleges should be taken for the purposes of instruction. Probably some colleges, when their funds accumulate by the running out of leases, and so on, will be in possession of incomes which will enable them to devote part of their money to University purposes. I have little doubt there are some such colleges, but the number would not include all the colleges. Some I daresay have not at all more than they can deal with fully, but I speak of course in some degree of ignorance there. The colleges manage their own business, and we do not know the exact amount of their funds; but I have not the slightest doubt that there are colleges which can, or will be able to, afford to contribute towards a University education. Most of them have done so under the Act of 1854, and I think this might be carried further; in fact, within the last year, Corpus has founded a professorship in law of its own free will, and endowed it, and Mr. Maine is now lecturing as the first professor under that endowment, and I have no doubt that can be carried further.

4190. We have heard that some of the smaller colleges have been making arrangements for teaching their students in common. Nothing of the kind has occurred at Christ Church, I presume, as you have so much larger a number of students?—In those science lectureships that I have spoken of they take young men from other colleges, and the reader in law and history takes young men from other colleges. In the classical department the tutors have quite enough employment with our own men without taking others.

4191. (Dr. Sharpey.) With regard to the nature of the course given by the Lee's lecturer on anatomy, is it on human anatomy chiefly or comparative anatomy,

or does it include both?—I almost think that you had better have the Reader before you. My own impression is that human anatomy is not much taught. The teaching is rather of a kind preparatory to professional study than actually professional.

4192. (Chairman.) You have already stated, have you not, that the portion of the income derived from the Lee's foundation, which is now applied in payment of the junior studentships is ultimately to be applied to the same purposes as the remainder of the income?—I do not say positively that it is to be, but I think it will be so applied if required. There is nothing under Dr. Lee's will to make it imperative to apply it so. He states various purposes.

4193. No scheme has been already drawn up with regard to the application of this fund when it all becomes applicable?—No.

4194. (Marquis of Lansdowne.) I think you spoke just now of the disappearance of pass-men from the science schools; that they were nearly all honours men. That was not the case, I believe, some years ago, as we have in evidence?—No, I think not; but that examination has been made, I believe, more severe in kind, and involves more of mathematics than was formerly the case.

4195. You expressed an opinion, did you not, that for pass-men a particular combination of literary and scientific culture was desirable?—I think so. I am told by those who have to deal with the lower kind of pass-men, that this is impossible. They say that they cannot get out of them what they get now properly, and therefore more would be impossible.

4196. And that one of the great difficulties of pass-men is requiring several different subjects, and that, therefore, if this further subject of science were added it would be almost impossible?—I do not myself hold that opinion. I think that the difficulty with pass-men is the necessity of producing exact knowledge. "You can get quantity," I have heard it said, "but you cannot get quality."

4197. (Professor Stokes.) With regard to a question proposed by the chairman, I think you expressed the opinion that it would be desirable to allow honours men to pursue their own lines without troubling them with other branches of study?—I may perhaps state that after a certain time, say about half of their University career, they can do so now; that is the present University course.

4198. Would you propose to alter that or to leave it as it is; I mean to require a certain amount, we will say, of literature, from all men before they branch off into the other direction?—I own that my own prejudices are in that direction.

4199. Up to what period of their course would you wish to unite the different branches?—I should like myself to leave it very free to honour-men; so long as they produce evidence of literary culture, almost at any period of their course, I should be content.

4200. Would you be in favour, in a similar manner, of requiring a certain amount, no great amount, of scientific knowledge from those who take honours in literature?—I have stated to his grace that I at present do not see my way to this. It would, I may add, so completely alter our present system, that I should like to see some definite plan produced before I ventured to pronounce an opinion. In what we call our final classical schools there is in fact a great deal, not of particular science, but of general scientific knowledge required,—perhaps I should rather call it philosophical knowledge than scientific,—which would form an extremely good basis for future scientific study. That has answered hitherto very well for training men and fitting them for different pursuits; and I should be loth to advise such an alteration without further and fuller consideration.

4201. You would be loth to see the quantity of scientific knowledge increased?—I should, so far as I can judge at present, hesitate to advise that a quantity of particular knowledge in particular sciences should be added to the work of what we now call our final classical schools.



4202. Do you not think it desirable that a person who takes honours, we will say in classics, should be required to exhibit a certain amount, no great amount, of exact knowledge in some particular branch of science?—I do think it desirable; but I am not disposed to recommend it at present, not without seeing some definite plan, and being able to judge how it would work in with our present system.

4203. (*Sir J. P. Kay-Shuttleworth.*) The Commission have had before them on the subject to which you have just adverted two very distinct proposals—the one has been that no honours should be obtained in science without the pass degree in literature having been first obtained, and the other has been that honours should be free without that pass degree; have you any distinct opinion upon those alternatives?—Yes. I do not say that I would exact the present amount of literary culture, but I should wish to see a certain amount of literary culture required of all men who pass through the Oxford curriculum.

4204. But you have not made up your mind as to whether the pass degree should be required of all men who take honours in science?—By a pass degree, I presume you mean an examination to test literary culture. I do not bind myself to the present one; but a certain evidence of literary culture should be given by every man who obtains a degree of science; that is to say, I wish to see that myself.

4205. We have had before us a proposal that students seeking scientific culture should be admissible to scholarships and to honours in the University, but not to fellowships, and so not to the government of the University, without taking a pass degree; would you give us your opinion upon such a proposal?—I never heard of the proposal before. It certainly would alter the whole character of our University system, and I am hardly prepared to give an opinion at this moment without considering it. As I understand it, those young men would be in the position of students studying at their own free will in the University, and receiving a certain allowance from some source or other; they certainly would be completely what would be called unattached students; they could not be brought into our present system at all, and I hardly venture to give an opinion upon that subject without further consideration. Perhaps I may add that I hardly think such a system could be permanent. There would very soon be a pressure on the part of these young men and their friends; and the University, having admitted them to its emoluments and its honours, could hardly refuse to admit them to a degree.

4206. (*Mr. Samuelson.*) Have you considered the question of the necessity of increasing the number of professors for the teaching of science?—No, I never have. We have had various proposals before us to increase them at different times; whenever the demand has arisen I think the addition has been made, but there has been no general plan, nor have we ever considered it. We prefer to provide for the need as it arises rather than to provide a large staff of teachers without any demand at the time.

4207. Taking into account the present requirements of Oxford, together with the increasing desire in the country that instruction in science should be extended, are you of opinion that there is such a demand for professors?—I have stated that we have not found it, so far as appears from the evidence of the open scholarships and studentships which are offered for competition; we do not find that the number of candidates is such as to lead us to think that we need increase at present, but I think we are quite prepared to do so the moment we find the demand increasing.

4208. In what way, when the demand shall arise, are you prepared to provide funds for the endowment of professorships?—That will have to be considered. I think that the University at present has a certain amount of funds at their disposal still available, but I think this is rapidly drawing to a close, and when that comes to pass we shall have to consider the subject. The University has no power to extract funds from the colleges, but I think that is the only

source that it can come from. The colleges have power to apply funds to such purposes, or at all events can acquire the power; if a college has not full power to dispose of its funds, it can get such power from the Queen in Council.

4209. So that, in fact, you think that the needs of the University in respect of science are met by the powers and funds which exist without any necessity for having recourse to legislation?—I think that the power exists, and I believe that when the demand arises the will will also be found to exist.

4210. From what you know of Oxford, is it your opinion that it is calculated to become more than it is at present, a school for professional education?—Take the case of medicine; I am not aware whether the question refers to professional education properly so called, such as hospital instruction, or the sciences introductory to the actual practice of medicine.

4211. I mean a school for everything short of actual practice, with access to the means of combining actual practice with instruction?—I am very anxious to see all that instruction given. From the time that I became a member of the University Commission, in the year 1850, to the present time, I have always striven to gain that object, and to a certain extent it has been carried into execution.

4212. But is it not the case that in certain professions it is necessary that the practice should be obtained during the period in which the general instruction is obtained, that the two should be concurrent?—I really cannot undertake to answer that question. In Dr. Acland's evidence, which I have had the advantage of perusing, I think it is stated that a considerable quantity of instruction may be given better apart from the practice, that before entering upon the practice there is quite enough to occupy a young man's time for several years, and he can not do better than devote himself to obtaining that knowledge before he enters upon practice.

4213. That answer, I believe, had special reference to medicine; but taking the subject of civil engineering, would you think that the same division there is possible, and if not possible, do you see any mode of providing an opportunity for practice in the University of Oxford?—I really am unable to say.

4214. (*Sir J. Lubbock.*) Would you be so kind as to tell us what branches of physical science are practically required in the competitive examination for the studentships mentioned in your previous answer?—They are examined in one or more of the three subjects in which we have readerships, viz., anatomy, chemistry, and physics; they are required to state in which of these subjects they wish to be examined, but we require them to be examined in one at least of those three, and then they may add any special subject they think fit.

4215. At present the fellowships of the University are given, are they not, to a much greater extent for literary than for scientific attainments?—Yes.

4216. Do not you think that that is very much the reason why there is less demand than might otherwise have been expected for scientific instruction?—Very possibly, if there were larger encouragement given in the way of fellowships, there might be more scientific students.

4217. So long as the fellowships, which are to a great extent the rewards of the University, are given in a very large proportion for one branch of knowledge, it is natural, is it not, that there should be more demand for instruction in that particular department than in another?—Yes, certainly. When I was speaking of demand and supply, I was alluding to instruction given and attainments gained before young men came to the University at all; the studentships and scholarships which I am speaking of, for which there is such a small competition, are for boys coming from the schools, and not for those who have been at the University.

4218. Can you expect that the schools which are preparing young men for the University should devote very much of their attention to subjects which

Very Rev.  
H. G. Liddell,  
D.D.

23 Nov. 1870.



Very Rev.  
H. G. Liddell,  
D.D.

23 Nov. 1870.

are but slightly rewarded in the University; is it not natural, so long as the great majority of fellowships are given for one kind of educational culture, that a school should prepare with special reference to that?—Yes, I have no doubt it is so.

4219. I do not quite understand whether you expressed an opinion that science should not be made an obligatory part of the examination for a degree. Would you not require from those who were going in for honours as much science as you expect from those who were going in for a pass examination?—I am not prepared at present to say "yes" to that.

4220. You would not consider a scientific education without any literary culture a satisfactory education?—My opinion may not be worth much on this point; but so far as I am able to form a judgment, I shall say, no.

4221. Surely is not a literary education without any science as one-sided as a scientific education without any literature would be?—I do not think that our literary education is altogether without science; it is without any particular science, but I think the foundations of science are taught; the reasoning and philosophical methods, and so on, are taught to a very large and wide extent, so that, I think, a man who has gone through our literary culture faithfully may approach scientific studies with considerable advantage. He has a good foundation laid in the grammatical, logical, and general philosophical training which he has received.

The witness withdrew.

Adjourned to Tuesday next at 12 o'clock.

No. 6, Old Palace Yard, Westminster, Tuesday, 29th November 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

Rev. J. Challis,  
M.A., F.R.S.

29 Nov. 1870.

The Rev. JAMES CHALLIS, M.A., F.R.S., examined.

4227. (*Chairman.*) I believe you are Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge?—Yes.

4228. I believe your principal work has been as professor of astronomy, rather than of experimental philosophy?—I was superintendent of the Observatory for a long time, but during a part of the time I gave lectures upon the physical theory of light and pneumatics, but when the observatory work was found too heavy, the Lucasian Professor undertook that department, so that after that I was confined to the work of the observatory. I might, perhaps, be allowed to say with regard to the term "experimental philosophy," that it is rather different from the term that we should adopt now, but I believe it was in consequence of the feeling at the time of the institution of this professorship, that experiments were wanted for the formation of theories, in accordance with the saying of Newton, "we want experiments," that the term "experimental philosophy" was adopted.

4229. You had for a long time the charge of the Cambridge Observatory?—Yes, 25 years.

4230. But I believe for some years you have retired from that office?—Yes, I left it in the year 1861.

4231. Will you be so good as to explain to the Commission what you consider to be the province of the different mathematical professors of Cambridge?—It has been the custom, by a sort of common understanding, to call three of the professors Mathematical Professors, the Lucasian, the Plumian, and the Lovndean, and our lectures have been gene-

4222. Still he would be entirely without any knowledge of physical science?—Of any particular science, certainly. I do not mean to express any strong opinion against the proposition; indeed, as I have before said, I should be glad to see a definite plan suggested for consideration; but I am not prepared to assent at once to a general proposition that all our candidates in *literæ humaniores* should also be examined in the details of some particular science.

4223. You would rather withhold an opinion than express it?—Quite so.

4224. (*Chairman.*) Have you any further remarks which you wish to make to the Commission upon the appointment of additional professors for the teaching of science?—I think it is a very desirable thing that professors should be appointed *ad hoc*; that if you found a man really able to teach any subject in the world we should have the means of allowing him to come to Oxford for that special teaching; and then, when he vacates, if there is no other man fit to take his place, you might transfer the fund to some other subject. I have always wished to see that done.

4225. Should you like to see eminent men resident at Oxford only partially employed in teaching, but employing a great part of their time in scientific research?—Very much, indeed.

4226. Are there any instances of that kind at Oxford now?—Yes, there are one or two; and a good many of those who are occupied in teaching have abundant time for independent research and study.

rally directed to the instruction of candidates for honours, in high departments of study, and we have seldom had attending our lectures any but such candidates. I think I may say that the university, with regard to those three professors, has always considered that they were doing what was in their duty if they pursued an independent scientific course, so as to promote science in any way that they could by means of mathematics or otherwise.

4232. Are you of opinion that, in the duties which devolve upon you, the application of mathematics is an essential?—I have always taken that view, certainly. Perhaps I may be allowed to mention in attestation of that, that I published last year a work called "The Principles of Mathematics and Physics." The mathematical part is altogether intended as subsidiary to the physical part, and the whole intention of the work was to bring into notice in the University of Cambridge the physical department of scientific instruction; but certainly when I wrote that work there was very little attention paid to that department, especially, I mean, with regard to heat, electricity, and magnetism, which are embraced in my work. The subject of physical optics had already received a good deal of attention, and lectures upon that subject, which were begun by Mr. Airy, have been continued since, and have been very efficient lectures. My idea was that now a time had come when we might make an endeavour to bring other physical subjects into the same relation to the studies of the University.

4233. You are of opinion, are you not, that the theoretical department of physics is in arrear of the



experimental?—Yes, I am decidedly of that opinion. I look at science in this way, the foundation must be laid in experiment; we cannot do anything without it, but the building is not complete with this foundation, there must be the superstructure of theoretical physics joined with experimental to make a complete building.

4234. And you think it is the duty of yourself and other professors of Cambridge, rather to cultivate the theoretical than the experimental department?—Always supposing that the experimental is sufficiently taken care of. I think that the first and foremost want at Cambridge has been the means of making experiments, the apparatus for experiments, and buildings for experiments. These we require before we can study effectually and go on to the theoretical department.

4235. There are measures now in progress, are there not, that will probably remedy that deficiency to some extent?—Yes; there are some things which we have done lately which, I think, will have very much that tendency. In the first place, we propose to have a professor with a demonstrator and assistant in experimental physics, and to endow a professorship for that purpose. That will provide, in great measure, for a very great want of the University of Cambridge. And another matter I might mention, which is, that we have recently introduced into the curriculum for honours, the subjects of heat, electricity, and magnetism; but that has reference only to the higher class of students. The professor of experimental physics will give lectures, which are more appropriate to those who are candidates for an ordinary degree.

4236. (*Professor Huxley.*) Does that teaching include the teaching of astronomical physics?—No, that would be provided for in a different way; that is within the department of the Lowndean Professor at present.

4237. (*Chairman.*) Will you be so good as to state to the Commission the present condition of physics in the course of the Cambridge mathematical studies?—I think that physics have not by any means been sufficiently attended to. The course of mathematical studies is in a great measure in the hands of private tutors, and they have it in their power almost to give direction to the studies. The university has power in this respect; it can say that such subjects shall be brought into the course, and they have done that lately, as I have just now said, with regard to heat, electricity, and magnetism, and this will compel those who instruct, whether private tutors or tutors of colleges, to turn their attention to those subjects, and to give instruction in them. And if those subjects are so introduced into the examination for mathematical honours that it becomes known that men get greater credit by attending to them, that will more than anything else tend to make them be studied in the university. If they find that by studying them they can get higher places and so increase their chance of a fellowship, that, I think, will tend more than anything else to forward the study of physics in the university.

4238. The new arrangements for examination in heat, electricity, and magnetism, have not, I believe, yet come into actual operation?—They have not, and will not till the year 1873, I think it is.

4239. Will you state to the Commission what provision the university has made for teaching physics, first as respects buildings?—A few years ago, about eight or nine years ago, there was a new building erected, which we call the Museums Building, but which is not adequate for the purpose of teaching physics. It is occupied a good deal by mineralogical, anatomical, and botanical collections, and there are also lecture rooms for lecturing upon astronomy and optics and other departments, but there are not conveniences for making experiments in physics. We want a new building for that purpose.

4240. What is the provision that the university has made as to teachers?—There has not hitherto been a professor of experimental physics, but I think that so far as regards the wants of the candidates for

honours, the three mathematical professors already mentioned, and the new Sadlerian professor of pure mathematics meet the present demands; and then there is the teaching in the colleges, but that must be teaching of a more general kind; but still some of the colleges in the university have entered upon a course of physical teaching, and provide for making experiments, and have laboratories.

4241. The teaching in the colleges has not, I believe, been in connexion with the teaching of the professors?—No, it has not. So far as regards physics it depends on voluntary individual exertion; it has not been organised in any regular way.

4242. Do you attach much importance to professorial teaching as distinguished from tutorial?—I think it is better suited to the higher class of students. I think that the tutorial teaching ought to embrace the general run of students; but those who wish to distinguish themselves, or who are capable of distinguishing themselves, may get advantage by attending the professorial lectures; but I am only speaking of mathematical lectures on physics, not of any other kind.

4243. What provision has the university made with respect to the annual expenses and purchase of apparatus?—A Grace passed, I think only a few days ago, by which every member of the university is to pay 17s. a year, and that brings in a sufficient amount to enable the University at once to make this new foundation of a professorship, and to name a sum to be appropriated for the endowment of a professor, of a demonstrator, and of an assistant, and the purchase of the appropriate apparatus.

4244. Has the university already made provision for the annual expenses of the existing museum?—I am not able to speak respecting the museums of botany, mineralogy, &c. We have not at the Cambridge University a physical apparatus at all. When we have purchased a physical apparatus, of course there will be the annual expense besides, and that the university will have to meet.

4245. Can you state to the Commission what, in your opinion, are the objects which induce students to undertake the study of physics?—Such a study as that must, in most cases, be a matter of taste or inclination, or of the character of the student's talent, but I think that there are many who may not have spontaneous inducements of that kind, who are induced by the emoluments and the advantages that the study gives them. I think that that would be the principal inducement, but we find that there are some who are not candidates for honours who voluntarily come to the lectures in order to get what information they can.

4246. From their taste inclining them in that direction?—Yes. The university has also instituted an inducement of this kind, that each candidate for the B.A. degree must be able to certify that he has attended a professor's lectures; but the students are left to choose their own professor; they may choose what lectures they will attend, and, of course, they are guided in that choice by their inclination.

4247. When you speak of the emoluments and rewards which they expect to derive from the study of physics, can you explain more particularly what you have in view; do you mean emoluments in university offices, or emoluments elsewhere?—There are several ways in which the expectation operates. There is of course the fellowship, that is a great thing, but that perhaps is only the stepping stone to something else. Then there is the prospect of being tutors, and in some degree of becoming professors; that is another inducement. But I think that a very great inducement is, that those who have gone through the Cambridge course expect to take positions in the educational institutions of the country, and the number of applications I have had for testimonials with that view during the 34 years I have been Plumian Professor has been very great indeed. I am engaged every year in examining the candidates for Dr. Smith's prizes; they are mathematicians of the highest order,

*Rev. J. Challis,*  
*M.A., F.R.S.*

29 Nov. 1870.



*Rev. J. Challis,*  
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29 Nov. 1870.

and a great number of them apply to me for testimonials to obtain positions in the country, or the colonies, and I think that that is one of the greatest inducements to getting a high position in the classes and studying science: they make themselves ready for taking positions in educational institutions.

4248. The number of students who devote themselves to scientific study is not large, is it?—No, it is but small. I must be always understood to say that I am not speaking of the department of chemistry, or botany, or anatomy, but only of those departments with which mathematics are connected.

4249. The greater number of those who take honours in the mathematical tripos at present apply themselves more to pure mathematics, than to applied mathematics?—Yes. I have been long of that opinion. I think that our honours course of study has gone too much into abstractions, and that it requires to be directed into the applied mathematics much more than into the pure. It does seem that many more students have an inclination to attend to pure mathematics than to applications of mathematics. We have, of course, such applied mathematics as mechanics and optics, that is, geometrical optics, and spherical astronomy, and so on; these have long been part of our course; but I have been desirous myself, for a long time, that we should add to those the sciences of heat, electricity, and magnetism, and what I understand generally by “physics;” and, as I mentioned, it was to promote that class of study that I wrote a work on the subject.

4250. As the new arrangements have not yet come into operation, perhaps you are not able to give us any opinion as to whether you think they are likely to produce much effect upon the character of the studies to which Cambridge men devote themselves?—We are very much dependent upon what the private tutors teach, but I think that when the physical subjects have become recognised, if men begin to see that by attending to them they shall get more marks (that is the technical way of saying it), that is, that they shall get better places, they will be attended to. I may state this as my experience. I have examined a long time the candidates for Dr. Smith’s prizes, and I have often put physical questions in that examination, and I have been very much satisfied by the character of the answers I have obtained; but the answers have at the same time shown me that those are not the subjects to which the gentlemen have paid special attention, that they have taken an interest in them, but that their attention has been much more devoted to some abstract portion of mathematics. And I should gather from my experience in such examinations, that our higher students might be turned very easily into a different direction, and they would excel in the application of mathematics to physics.

4251. As the examination for mathematical honours is to be divided into certain divisions, it will not be compulsory upon the candidates for honours to pass an examination in physics?—No, it will be optional. According to the present arrangements they may choose their subjects.

4252. There are several papers in each division, and they may select which they please of those papers?—Yes; but it is also the case that the same paper may contain the subjects of several divisions, and the choice of subject is still left to the student.

4253. Heat, electricity, and magnetism will be amongst those subjects which are optional, will they not?—Yes, according to the schedule.

4254. I believe there is some arrangement made as to marks which it is hoped will act as an inducement to encourage students to apply themselves to those studies?—Yes; the greatest proportionate number of marks they can obtain in them is to be mentioned; that is to enable them to make a choice relatively to the other subjects. There is not proposed to be given as much credit as I should like to the new subjects, but it was felt that those subjects must make their way by degrees, and as they become more attended to they will rise in value in the examination,

4255. Have not some of the colleges offered fellowships for proficiency in those studies?—Yes; at Trinity College they have actually awarded a fellowship for physics. The examination was in physics expressly, and at the last decision of fellowships there was one awarded for proficiency in physics.

4256. Should you like to see the number of such fellowships increased?—I should, but always with the understanding that as much as possible this study should be conducted by means of mathematics, that it should not be dissociated from mathematical studies. I have always desired to see the union kept up between mathematics and physics. In the case of such an inducement to study, and so great a prize as a fellowship, I think such a prize as that should not be given simply for knowledge of experiment, but that it should be given for a combination of experiment with applications of mathematics.

4257. You would not like to see any person obtain a fellowship without being a sound mathematician?—No, I should not.

4258. I think you spoke just now of the attendance upon some professor’s lectures being required from candidates for an ordinary degree: is a regulation to that effect at present in operation?—Yes; each person must present at the registry a certificate that he has attended a certain number of lectures of some one professor, before taking his degree.

4259. I believe I am correct in supposing that at present the candidates for ordinary degrees have to pass through two examinations, one called the previous examination and the other called the general examination?—Yes.

4260. And after that they may devote themselves to any particular study and obtain a degree by passing an examination in that study alone?—Yes; that is the present arrangement.

4261. Has that arrangement been some years in operation?—But a short time, I think; I cannot say precisely how long.

4262. Are you able to state how that system is working?—It is scarcely in my department. I am rather prepared to speak on those points in which the higher class of students are distinguished from the candidates for the ordinary degree. In fact, the number of changes that have been made as to the examinations in the university of late have been so great, and have followed each other so quickly, that a man of my standing has very considerable difficulty in keeping them in mind.

4263. Have any candidates for ordinary degrees been in the habit of attending your lectures?—I have had but very few; I have had sometimes persons specially attending who have been preparing to go out either to India or to the colonies to superintend some astronomical department, and I have occasionally had foreigners attending my lectures.

4264. As the candidates for the ordinary degree are obliged to attend the lectures of some professor, do the professors adapt their lectures specially for ordinary pass men?—There was this provision made, that the three, or rather I should say the four, mathematical professors are not included amongst those that that class have to attend, not being empowered to give certificates of attendance on lectures for the B.A. degree. Such certificates are given by the professors of chemistry, botany, geology, anatomy, and zoology. Professor Willis’s lectures, those especially on mechanism, do not come under the same class as those of the four mathematical professorships, he being empowered to give a certificate for attendance upon his lectures.

4265. As the ordinary pass men do not attend your lectures, you are perhaps hardly prepared to state what kind of lectures you consider most appropriate for ordinary students?—Not from any personal experience; but still I have an opinion upon it. I think that those who come to take an ordinary degree, supposing that they have had the rudiments of education in mathematics and classics, are prepared for attendance upon lectures of the kind of botany or geology, or



zoology; but I should not think that they are very well qualified, that is mentally qualified, for attendance upon such lectures without having had a previous elementary education. I think that a specific education in classics and mathematics prepares them as it were for receiving benefit from other kinds of lectures. When you come to lectures on botany, geology, and comparative anatomy, classification is the principal thing. To learn to classify, to arrange, to put things in the right order is a great accomplishment; and I think that attendance upon such lectures is of very great importance, considered with reference to a general education. But that is entirely different from prosecuting the study of mathematics, the effect of which, of course, is to sharpen and to mature the reasoning powers.

4266. (*Professor Huxley.*) Is there not also another reason for thinking it desirable that there should be a preliminary training in physics and mathematics before a person's taking up natural science, namely, that so far as the natural sciences are what I may call sciences of cause and effect, apart from classification, the understanding of those causes and effects entirely depends upon a previous knowledge of physics, chemistry, and mathematics?—I do not think that physics can be studied with reference to cause and effect apart from the mathematical study of them. I think that the study of physics anterior to mathematics is simply a study of facts and laws; but if you come to reasons for things, I do not think you can arrive at those without joining with such a study, the study of mathematics.

4267. My question was intended rather to strengthen your position with regard to the study of physics and mathematics before that of the natural sciences, and to show that so far as the natural sciences are concerned with causes and effects, those causes and effects could not be understood without a previous knowledge of physics and chemistry, and mathematics. That is also a ground in your mind, is it not, for wishing that persons who study the natural sciences should go through a preliminary course of study of physics, chemistry, and mathematics?—I should not put those three together, physics, chemistry, and mathematics. I think, that for an ordinary physical education Euclid and the elements of mathematics are all that is necessary. In whatever department physical science is afterwards studied, I think it may be studied with advantage by those who are not candidates for distinction, but who wish to study for the sake of education, and that the studies of chemistry, botany, and geology are educational, but educational in a different sense from those physics with which mathematics are associated.

4268. Would not you consider the study of chemistry as much a subject preliminary to the study of what we commonly call natural science as the study of physics?—If by the study of physics I understand you to mean heat, electricity, and magnetism, I should say that chemistry might very well precede those studies, because by studying chemistry before, we know the facts to which those phenomena relate; we must know some facts beforehand. But viewing the subject in a different way, that is in relation to inquiry into cause and effect, I should place chemistry as a study which should come after heat, electricity, and magnetism.

4269. That is to say after physics?—Yes, because I think that we must make advance in knowledge of those phenomena before we can arrive at the reasons for the chemical facts.

4270. So that in fact, chemistry, in the long run, would be an application of the higher physics?—Yes, I should say quite so.

4271. Are you satisfied with the position which is given to science in the University of Cambridge at present as a qualification for an ordinary degree?—I think that the study of science might very well be increased in the direction of attention to physical facts and physical phenomena.

4272. It is the fact at present, is it not, that an

ordinary degree can be taken without any knowledge of what is commonly understood as physical science?—I think that we certainly have been behind-hand at Cambridge, in that respect, and that we might advance in that direction with advantage.

4273. Would you like to see a greater amount of physical science made obligatory before a person could take a degree?—Yes; it is already so in some measure, but I think it might be made so in a greater degree.

4274. How much physical science is now obligatory before a person can take his Bachelor of Arts degree?—He is not obliged to take up physical science, but if he does so, he must attend the lectures of some one professor in the physical department, and he must receive a certificate of having so attended.

4275. But there is no examination?—No, there is no university examination. There is the examination by the professor himself before he gives the certificate, but there is not any other examination.\*

4276. If a person attending his lectures passed a very bad examination, and the professor refused his certificate, that person, I presume, could not take a degree?—No, he could not take a degree without a certificate.

4277. May a person coming up for examination select any subject he likes, and may he attend any lecture in physical science that he chooses?—Yes; there are certain professors named whose lectures he may choose from, that is to say, some one of the named professors he may select, but the choice is left entirely to himself.

4278. So that, subject to the strictness of the professor, a person cannot actually take a degree at Cambridge without some knowledge of physical science?—No, he cannot if he takes up physical science.

4279. As I understand, you would like to see the amount of that knowledge very much increased?—I think we might advance in that direction with advantage.

4280. May I ask in what directions you would like to see the amount of physical science increased?—I think that attendance upon the lectures of only one professor is hardly sufficient. Perhaps it would be undesirable to induce students to attend upon the lectures of more than two professors, but so much, I think, might be required, for the following reasons: The professors who give certificates are not all professors of natural science. For instance, a certificate for the B.A. degree can be obtained by attending the lectures of the professor of modern history. Attention to physical science might be secured by requiring attendance upon the lectures of two professors, provided always one of them is the new professor of experimental physics.

4281. Do I rightly understand you, that modern history may be taken to represent science at Cambridge?—No, I did not mean that. I am not quite *au fait* at these matters of detail, but I believe that I am correct in saying that the professor of modern history can give a certificate for the degree of B.A.

4282. (*Professor Stokes.*) You spoke of a tax which was imposed the other day by a Grace of the senate on the members of the university; was not that merely that a previously existing tax was continued?—It was a tax to the same amount as the previous one, but there had been an arrangement made just before that the colleges should pay what the university had paid towards the improvement rate of the town. That, of course, relieved the university from that payment, but it was still thought that they might impose this tax under the different circumstances, and a fresh Grace was considered necessary, because the circumstances were altered.

\* [This statement does not apply at present. In 1869 a new regulation came into operation, according to which the professor only gives a certificate of attendance at his lectures, and examiners appointed by the university conduct a public examination, and give certificates of approval for the B.A. degree.—J.C.]



Rev. J. Challis,  
M.A., F.R.S.  
29 Nov. 1870.

4283. Then the upshot of the whole is, that in fact the colleges have contributed out of the funds which they had at their disposal to university purposes, although in an indirect way?—Yes, certainly.

4284. You have been for a long time professor in the university; would you have the goodness to state to the Commission your opinion as to the relative state of things now and formerly, with regard to the study of physical science; has it advanced, or the contrary?—When I first went to the university there was scarcely any attention paid to physical science. There was a tradition of lectures having been given by Professor Vince, but the physical apparatus he left was of an obsolete character, and of very little use. Mr. Airy, when he was made Lucasian Professor, in 1826, began a course of lectures on mechanics, pneumatics, and optics, including physical optics, and those lectures gave a great impulse to the studies of the university; and from that time physics have not been neglected, although we have not perhaps made the advance that we might do, considering what has been done outside the university. But the lectures on physical optics began by Mr. Airy have been continued, first, by myself when I succeeded him in 1836 as Plumian Professor, and subsequently by Professor Stokes, with the introduction of all the accessions the science has received in the intervening time. So that in regard to that particular application of mathematics, that is, the undulatory theory of light, we cannot be said to fall behind any institution at all; but there has not been a corresponding attention paid to physics generally.

4285. But still, do you think that the study of physics has fallen off, or otherwise?—I do not think it has fallen off. I should not say that there had been any falling off in the study of physics. I think that the young men in their reading attend to mathematical applications as much as at any former time, and that physical subjects, as far as existing circumstances permit, are brought into the examination.

4286. You stated it as your opinion, did you not, that the questions proposed for mathematical honours were of rather too abstract a character?—I think that there is too much of pure geometry and too much of pure analysis; that questions in these subjects bear too great a proportion to the whole number of questions. I think that what is called superior geometry is carried on to a great extent without involving any new principle, and therefore is not really informing to the students; it is simply an extension, such as you might make of geometry by problems and deductions: it does not amount to much more than that, and I think that the time which is devoted to such extensions might be profitably devoted in the direction of physics.

4287. You spoke of the want which at present exists in the university of means for making physical experiments. Is it your opinion that that want leads the students and their private tutors, who become private tutors just after they take their degree, away from the study of physics to such studies as they can pursue, simply by reading and writing?—I think it is so, and I think that that accounts in a great measure for the character of our mathematical examinations now.

4288. (*Marquis of Lansdowne.*) With regard to the pupils who attend the lectures of which you have spoken, should you say that the majority attend in order to qualify, to obtain a certificate for the degree examination, or from a simple desire to become masters of the subject?—I think that the majority are induced to attend them simply because it is necessary in order to obtain the certificate.

4289. Are the examinations by the professors on which the attainment of a certificate depends annual or otherwise?—They are annual, because the degrees are conferred annually, but every one, before he takes the degree, has to obtain a certificate of approval after examination.

4290. That certificate being contingent upon pass-

ing a private examination by the professor?—Yes, he must give satisfaction to the professor.\*

4291. (*Chairman.*) Is it your opinion that when the new professor in experimental physics shall have been appointed, any further addition to the number of professors in science at Cambridge will be required?—I have a doubt upon this point. I question whether one professor will be able to meet the case, that is, whether it will not be too laborious a position for a single professor, on account of the number of students that will have to attend his lectures. He will have a demonstrator and also an assistant, but I almost question whether there will not be too much for one professor to do. However, I think that that is a matter which must be decided by experience.

4292. Do you think it may be necessary to have two professors *in pari materia*, or that their work should be divided?—They might divide the labour in any way they judged on experience to be best, but I think that the responsibility should not be borne by only one professor. That consideration has suggested itself to me, because this professorship is to be provided for the whole university, and attendance on the lectures might, as I have suggested, be required as a qualification for the B.A. degree. I think at Oxford the case is that Professor Clifton is the sole Professor of Physics or Professor of Experimental Philosophy, and he has an assistant, I believe, but I know that he has very hard work.

4293. Can you give us any idea as to the number of young men that in your opinion one professor of experimental philosophy could have attending his lectures with advantage?—It is well known that very large numbers attend upon the lectures of the Scotch professors. I have heard of a class of as many as 200, but I concur in the opinion I have heard expressed that 30 is about the maximum that a professor can well attend to, and where that number is exceeded the lectures cannot be of such an individual character as is desirable.

4294. (*Dr. Sharpey.*) You are probably aware that the lectures given by a Scotch professor are simply prælections: there is no individual teaching of individual students; and it makes no difference whether he has 100 or 300, provided they are within hearing and seeing?—Just so; that makes a great difference.

4295. (*Chairman.*) Have you ever heard that there has been any fear that the requirement that the ordinary pass men should attend the lectures of certain professors might have the effect of lowering the character of the professor's lectures?—No, I do not remember that I have heard that stated. It is no doubt a very difficult matter for a lecturer to accommodate himself to all the students who attend, and of course one of the things he should aim at is, to make the lectures generally intelligible; he cannot do more than that.

4296. Are there any other points which you would like to go more fully into?—I do not remember any at this moment. I have given some prominence to what I consider a very essential point, that is to say, that the studies of the University of Cambridge in the higher departments of physics should always be regarded as mathematical, and that all arrangements, should, as it were, be considered subordinate to the prosecution of physics by means of mathematics. That is the principal point which I wished to bring forward.

4297. (*Professor Stokes.*) You stated that Trinity College had lately given a fellowship for physics, awarded by an examination held in that branch. Is it not the case in most of the colleges, that the fellowship is determined by the result of the degree examination, without a separate examination for the fellowship?—Yes, I believe that is the case. In all the smaller colleges I think that is the case.

4298. Then is there any obstacle existing to the granting of fellowships for distinction in physics in

\* [By a change which came into operation in 1869 the certificate is now given after a public examination by examiners appointed by the university.—J.C.]



those colleges?—No; I think it would be a very good thing to do.

4299. And they have the power at present, have they not?—Yes.

4300. And sometimes they exercise it?—Yes; I am not aware of any instance in which they have given a fellowship for excellence in physics, except at Downing. I may perhaps mention that at the examination at Trinity for the fellowship in physics, there were but three or four candidates, but they acquitted themselves very well, so that there was quite a deliberation in the society whether they should give two fellowships or only one. They thought perhaps as it was the first time, one might be sufficient, but there was a wish expressed on the part of some to give two fellowships, as two of the candidates had acquitted themselves very well.

4301. (*Chairman.*) So far as that instance goes, it seems probable that if more fellowships were awarded for proficiency in physics, suitable candidates would present themselves?—I quite think so.

4302. Do you think it desirable that any scholarships should be awarded to encourage the study of physics?—I think so, because that may determine at an earlier period of the university course the students to direct their attention to physics. I think it rather better that there should be some indication of that kind of their having acquired a proficiency, than being at

The witness withdrew.

J. C. ADAMS, Esq., M.A., LL.D., F.R.S., examined.

4304. (*Chairman.*) I believe you are Lowndean Professor of Astronomy and Geometry in the University of Cambridge?—I am.

4305. You also, at present, have charge of the Cambridge Observatory?—Yes.

4306. I believe you give one or more courses of lectures every year?—I give one course of lectures in the year on some mathematical subject connected with physical astronomy. For several years past I have lectured on the lunar theory, and in my next course I intend to lecture on the figure of the earth.

4307. Do any considerable number of the higher men attend your lectures?—Not more than about six or seven have commonly attended.

4308. Will you be so good as to favour the Commission with your views as to the light in which instruction in science should be regarded?—I think it highly desirable that we should endeavour to awaken an interest in the study of the physical sciences, and that all those who evince any power or special aptitude for such study should be encouraged and assisted in the prosecution of it; but I am strongly of opinion that this study should be carried on in conjunction with mathematical and literary studies, and should not be regarded as a substitute for them. A student of science cannot, without great loss, dispense with the mental training which these studies supply. No great progress can be made in some branches of physics without a knowledge of mathematics, whilst in all branches such knowledge is highly useful. For the formation and establishment of sound physical theories I consider mathematics to be indispensable.

4309. You think that no enduring physical theories can be established without a thorough knowledge of mathematics?—I do; such theories require a mathematical basis.

4310. You would not wish mathematics and physics to be studied to the exclusion of literary culture?—Certainly not. I think that literary culture is extremely important, that without it the mind is apt to become narrowed, especially if it be exclusively devoted to material objects, and that in consequence even physical studies themselves are likely to be pursued with less success. I should not, therefore, be at all in favour of establishing separate schools of science where the scientific studies should take the place of literary or of mathematical studies. I think that when once an interest in physical science had been created, it might be studied without leading to

once called to an examination for a fellowship. I think that the same reason exists for having scholarship as well as fellowship examinations, as in the department of mathematics and classics, where we know there are scholarship examinations as well as fellowship examinations, and the one is a step as it were to the other.

4303. Have you at all considered the question whether it is desirable that the study of physics should be reserved to a late period of education, or do you think that any foundation might be laid in the schools?—I am myself rather inclined to the opinion that, considering the time that boys are at school, it is best to devote it to classics and mathematics. It is, however, to be said that the age at which they leave school now is rather different from what it used to be. I remember the time when it was a general thing for boys to have a year's interval between the school and college, and that year they spent with a private tutor; but now it is much more generally the practice to continue at school up to the time that they go to the university, and that extension of time does, I think, leave an opening for some attention to physics at school, so that I should not think that any detriment would be done to their education by attention to physics for the year before they leave school, but I think that a foundation in classics and mathematics is still equally necessary for education.

The witness withdrew.

the neglect of the ordinary subjects of school education, and that, in fact, through the greater variety in the subjects to which the mind would be directed, the study of the ordinary subjects might be rendered even lighter than it is now.

4311. Do you approve, generally, of the present Cambridge system, by which a certain foundation both in classics and mathematics is required?—I do. I should be sorry to dispense with a general examination of all our students, such as our present "Previous Examination."

4312. At a certain period, do you think that classics might be laid aside, and that the students' attention might be devoted solely to mathematics and physical science?—After a certain time, and after a certain amount of culture had been insured, I should be disposed to allow that.

4313. Do you think that the study of physics might become more general than it is at present, and that a great many more students might under any circumstances be induced to take up the study of physics?—I think that a greater number might perhaps be induced to take up the study of physics, but I do not look upon that as the main object to be sought for. I should rather be inclined to encourage students to take up such subjects as they would really make proficiency in. I think that physical studies are not such as would be likely to occupy the minds of the majority of young men with much advantage, and I should be afraid that minds in general would be content with a smattering of knowledge on a great many physical subjects, and would make the acquirement of such knowledge a mere matter of memory, without having their reasoning powers called into play.

4314. Then you would not look with favour upon any proposal to make a certain amount of knowledge of physical science indispensable for a degree?—No, I should not.

4315. Would you give the student full liberty to select the special subjects that he would study?—I should attach great importance to that. I think that, for the improvement of the mind of the student, it is very essential that he should devote himself to a particular study, and go with considerable thoroughness into that study. It is not the mere amount of knowledge that I should look for, but the thoroughness and the connexion of that knowledge within a certain range. If within a certain limited range a student's knowledge is coherent, so that he can connect one fact with another, and see the dependence of a great

Rev. J. Challis,  
M.A., F.R.S.

29 Nov. 1870.

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29 Nov. 1870.

number of facts on certain definite laws, I think his mind is infinitely more benefited than it would be by the acquirement of a greater range of so-called knowledge, which after all only amounts in many cases to a mere exercise of the memory. I should desire to encourage the selection of special studies which might be thoroughly worked out, rather than to require knowledge spread over a great surface.

4316. Have you in view any special methods by which you think that this mode of studying a subject could be encouraged?—I should be guided a good deal by the taste of the individual student. I should try to awaken an interest in physical subjects generally, and if I found a taste in any student for a particular subject I should encourage him to devote himself to that subject, and reward him if he successfully cultivated it.

4317. Do you look to this result being obtained mainly by private study, or do you think that much assistance can be rendered to a student by the professor in that branch of knowledge to which he devotes himself?—I consider it essential that he should have the guidance of a good professor in the subject to which he devotes himself; he might lose a great deal of time and labour unless he were properly guided, whilst it would be the greatest possible encouragement to him to have an eminent man at the head of the particular branch of study to which he devoted himself.

4318. Have you yourself any individual knowledge of the attainments and capacities of many of the students who attend your lectures?—In the course of my lectures I generally find out what the students are capable of, because I give them problems to work connected with the subject of my lectures.

4319. It is not merely a lecture then?—Not what is ordinarily termed a lecture, but, like most of our university lectures, it is accompanied with a certain amount of examination.

4320. Does this apply to professorial lectures as much as to tutorial lectures?—Not so much, but it does apply to some of them.

4321. What are your views as to the best means of discouraging cramming?—I think that I have mentioned already that the devotion of a great deal of attention to the thorough working out of one subject would be the best means of really discouraging cramming. When a great range of knowledge is required to be got up by a student in a short time, it is almost impossible to avoid cramming to a certain extent. If a subject be spontaneously taken up on account of the interest felt in it, the student will naturally be led to devote his mind to grappling with its difficulties, instead of merely allowing himself to be helped over them by his teacher.

4322. Do you think that more than a small proportion of students will ever be of the calibre to study in the spirit which you would like to see?—It is quite true I do not expect that more than a small number would, but I greatly doubt the advantage of inducing men who are not of sufficient calibre to understand the scientific connexion of the different parts of a subject to devote much time to the study of it. Science, it appears to me, is in its very nature, systematic, and unless the knowledge acquired by the student has this systematic character, he will gain little or no advantage.

4323. Are you of opinion that physical and scientific studies have hitherto received their fair share of attention at Cambridge?—By no means; I think they have been somewhat neglected at Cambridge, but I have great hopes for the future. The professorship of experimental science which is about to be established will, I think, give a great impulse to such studies in Cambridge, and I have no doubt that the colleges will follow in encouraging scientific studies.

4324. Certain branches of physics have long been studied at Cambridge with great success, have they not?—Yes; for instance, the subject of light has long been thoroughly studied under the guidance of Professor Stokes, and previously under that of Professor Airy, now the Astronomer Royal, and of Professor Challis. There are many subjects, however, that

have hitherto received very little attention. Some of these, indeed, have only recently attained a sufficiently advanced state to render them fit subjects for academical study.

4325. In addition to the new professorship, do you contemplate supplementary instruction being given in the colleges?—I think it is very important that such instruction should be given, and I have no doubt that when a good professor has been appointed to represent physical studies, the colleges will take them up. I think that the colleges will probably establish supplementary laboratories, one college taking up one subject and another college another, and admitting students of all colleges to the respective laboratories, so as to prepare the best students for profiting more by the labours of the professor.

4326. Some steps, I believe, have already been taken in that direction?—Yes. They have a laboratory at St. John's College, and I believe also at Sidney and Downing, and they have adopted the plan of admitting students belonging to other colleges.

4327. Do you think it is desirable that instruction in the colleges should be in any degree under the guidance of the professors of the respective departments?—I think not. The colleges would naturally follow the lead of a professor who was a competent man, but I think it would be better to leave them perfectly free.

4328. Do you consider that a part of the duty of a scientific professor in addition to giving lectures on his subject, is also to endeavour to extend the boundaries of his science?—I look upon it as a most important branch of the duties of a professor to endeavour to do so. I regard that as a much more important part than the mere teaching, because this can be done, to a great extent, by assistant professors. The professor should undoubtedly give a certain amount of his time to lecturing, but I think that his main object ought to be to endeavour to advance science: he would thus do more in an indirect way to encourage the study of science in the university than he could by any amount of teaching. The students will be carried along with much greater spirit and *élan* if they know that they are led by a man who has original power.

4329. The requirements of Cambridge, in respect of professorial lectures, are not such, I presume, as to take up the whole of the professor's time?—No, by no means.

4330. They leave him a good deal of time at his his own disposal, do they not, for original research?—They do, certainly.

4331. (*Dr. Sharpey.*) Has it occurred to you that any special steps might be hopefully taken by the University for promoting the advancement of science through the university by original research in addition to what is done already?—I do not know that anything special has occurred to me. I have long been of opinion that we might utilize our fellowships more than we do by more frequently electing into them men who had distinguished themselves by special services to science. Fellowships are now given almost exclusively by the results of university and college examinations, but I think it would be highly desirable that they should be also given for eminence in particular subjects of study, eminence proved by actual work done.

4332. So that a person holding such a fellowship might have leisure and opportunity for devoting himself to the advancement of a particular branch in which he had shown distinction?—Yes, and to some extent this is being done at present: for instance, in some cases, where the endowment of a professorship is inadequate, a college has elected the professor to a fellowship, thus enabling him to devote his time more completely to the pursuit of his own branch of science.

4333. (*Chairman.*) That applies to Professor Challis, does it not?—It does; he has lately been re-elected a Fellow of Trinity.

4334. (*Mr. Samuelson.*) You spoke of additional interest being awakened amongst the students at the university in favour of science; in what way would



you propose to effect that object?—I think that the appointment of an eminent man as professor of physical science, and the experimental lectures that he would give, would naturally awaken a great interest in the minds of many students, but I should let the attendance on those lectures be quite voluntary.

4335. Would not the same object also be served by allotting a greater number of scholarships to science than is the case at present?—I am not much in favour of interest being awakened by the motive of immediate material advantage. I should certainly be inclined to reward proficiency in science, but I would rather allow that reward to come later, after satisfactory proof had been afforded that the scientific study had been well directed. I am not in favour of giving large scholarships to young men in their first year. I think they often tend to foster self-conceit and to encourage idleness. I have known several cases in which men who have got valuable scholarships have been afterwards beaten by those whom they had beaten in the first examination.

4336. Then you think that science has relatively a better chance, on account of the fewer scholarships being offered for it?—I think that pure science would gain little by the offer of immediate pecuniary advantages. I would rather look to the end. When men have given proof of having applied themselves with real purpose and effect to scientific studies, I should say that they ought to be rewarded; such rewards would then enable them to devote their leisure to the advancement of science; whilst if they are given too early, they are apt to defeat their own purpose. This remark is, I think, applicable to literary as well as to scientific studies.

4337. Can you state what is the number of scholarships offered for science as compared with those offered for classics and mathematics?—At present there are few, but they are increasing in number. Several of the colleges are now offering scholarships for proficiency in natural science, but the number of properly qualified candidates has as yet not been large.

4338. The instruction in the schools being inadequate, I suppose, to enable young men to come up sufficiently well prepared?—Yes. I do not suppose that the schools generally have devoted themselves much to physical science. A good deal of what I have said about those studies in the university will apply quite as well to schools. I think that a careful regard ought to be paid to the development of any decided taste that may exist in a boy; but I would not require a certain amount of scientific knowledge from all, since where there is no congeniality of mind on the part of the boy, his time would be wasted or be taken from some other study which might profit him more.

4339. But would not that apply equally to classics and mathematics, if a boy had no predilection for those studies?—I do not think so. I consider both of these requisite, to a certain extent, as the groundwork for all other study. I do not think that the study of physical science comes under the same category as mathematical and literary study.

4340. Is there any obstacle in the statutes of the different colleges which would prevent them from giving additional encouragement to science if they thought that it would be desirable?—I think not, though it is possible that some of the statutes might require modification in order to facilitate the election to fellowships of eminent men who have not been previously university students.

4341. Have they the power within themselves to make the necessary modifications, or would they require to apply for power?—I think they would require to apply to the Crown.

4342. You have stated that you would not establish special schools of science where science should take the place of literary studies, but with regard to the

case of professional students, who cannot afford the time for literary as well as for scientific studies, would you also make the same objection?—I was not then speaking of preparation for any particular profession, but of general intellectual culture, the importance of which cannot, I think, be overrated. For professional students it might be allowable somewhat to modify the system.

4343. You look upon a technical school as a good thing in itself, but by no means as a substitute for a university?—Quite so.

4344. (*Chairman.*) I think you stated that you thought that the disposal of fellowships might be rendered more useful to the university: should you desire to see a larger number of the fellows employed in the university work than at present?—I am not certain that I should. I think a great many of them are employed in doing university work, either as private or as public tutors. What I should wish for would be the employment of a greater number in original research. I think that by electing to fellowships such men as had already shown that they possess original power we should probably secure that object.

4345. Then would you take them from outside the limits of the university?—Either outside or within.

4346. I think we gather it as your opinion that it is at least a doubtful advantage to diffuse widely an elementary knowledge of physics, and that you would be rather disposed to encourage such studies only amongst those who have a predilection for them?—Yes, I think that such studies should be taken up spontaneously, and that any student who desires a knowledge of physics should have every opportunity of acquiring it.

4347. I believe the University of Cambridge has very little property of its own?—Very little; the University chest, out of which several professorships have been endowed, is extremely low.

4348. The demands upon the chest at present are, you think, fully equal to its capacity?—Yes.

4349. (*Mr. Samuelson.*) I suppose that the colleges have ample funds?—The colleges have funds, but they are very jealous of any interference with those funds on the part of the University.

4350. (*Chairman.*) Has not an arrangement been recently arrived at, which practically places an income of about 1,200*l.* a year at the disposal of the university at the expense of the colleges?—Yes.

4351. (*Mr. Samuelson.*) Is that capable of extension?—I am afraid not.

4352. Is there any legal hindrance to its extension?—Yes. I do not think it would be capable of any expansion in that form.

4353. (*Chairman.*) If anything more is done, it must be done, I presume, by the colleges consenting to tax themselves for general university purposes?—Quite so. I think there is a disposition on the part of many of the colleges to submit to a tax of that kind, but there is a great difficulty in getting so many different bodies all to consent. The different foundations are quite independent; their fellowships differ very widely in value, and, therefore, a tax on the revenues of the different colleges, although apparently equal, might turn out to be very unequal in practice. This difficulty has been very much felt in the university, and it has been a great obstacle to the consent of the colleges to a common rate of taxation.

4354. Do you think that that is the obstacle which principally stands in the way?—I think it is. There was a great disposition on the part of many colleges to consent to a tax for the sake of establishing the physical science professorship, but a few stood out.

4355. Does the objection come mainly from the poorer colleges?—It comes mainly from those colleges that are either poorer or that have expended a large amount of money lately in other ways, and which therefore would feel the pressure of the tax more.

The witness withdrew.

Adjourned to to-morrow at half-past 11 o'clock.

J. C.  
Adams, Esq.,  
M.A., LL.D.,  
F.R.S.

29 Nov. 1870.



No. 6, Old Palace Yard, Westminster, Wednesday, 30th November 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

GEORGE MURRAY HUMPHRY, Esq., M.D., F.R.S., examined.

G. M.  
*Humphry, Esq.,*  
*M.D., F.R.S.*

30 Nov. 1870.

4356. (*Chairman.*) I believe you are Professor of Anatomy in the University of Cambridge?—I am.

4357. I need scarcely ask you whether the teaching at Cambridge is mainly mathematical?—It is.

4358. Do you consider that there are any deficiencies in the mathematical teaching at Cambridge?—I ought to premise, before venturing upon remarks on such a subject, that I had not the advantage of an early Cambridge mathematical education, and, therefore, it may seem rather presumption in me to speak of defects in the mathematical teaching; nevertheless, having resided in Cambridge for 28 years, and known a very large number of the members of the university in all stages of their progress, and having heard a great deal of the opinions of them and of other men who occasionally visit Cambridge, I have arrived at some conclusions. My impressions with regard to the teaching of Cambridge are, that it has not a sufficiently practical bearing. The prime object of the teaching at Cambridge is to train the mind to clear, accurate, close thought, and to enable it to grapple with abstract problems, and that, of course, is highly important, but it should not be, I think, the sole object. There are some minds that are incapable of it, though capable of being educated for other work, and those minds in which it succeeds would be improved if other faculties were cultivated also. As it is, they are liable to be what one may describe as rather one-facultied, in consequence of the too exclusive cultivation of this one faculty under rigid training. They appear to me in many instances to have too little elasticity and pliability and capability of appreciating other matters, and too little enterprise. The object, I think, should rather be to cultivate pliancy and adaptability and readiness, as well as strength, and to educate the various faculties more equally. In this I think the university rather fails, and does so for want of the habit of bringing the mind into contact with the real problems of matter and life. This becomes counteracted very much in those who move away into the life and facts of the world around, but operates prejudicially upon those who remain and hand on the system of education to others, so that the evil has rather a tendency to grow. Considering the amount of talent which is drawn to Cambridge, the time and pains spent in teaching and learning there, and the forcing power in the way of money capital which is used, the result is not so great as it ought to be, even as regarding the mental effects upon those who go there. I think that it would be very much increased in the case of those who do resort to the university, and also in the numbers who would resort to it, and in the influence upon the country at large, if a wider range were taken and a more practical character given to the studies, or rather a more practical application of knowledge cultivated. At the same time the advantage to science and scientific men of the Cambridge education would be very great, forasmuch as it tends to check hasty assumption and promote careful investigation and give a more logical character to deduction. The deficiency I speak of is necessarily attended with a great loss of interest in the work, inasmuch as practical illustration and practical application seldom fail to create an interest in the student; and to excite that should be one of the great

objects of a teacher. A more thorough system of practical application would attract practical men much more to the university and to science, and would tend, I cannot doubt, to obliterate the ruinous fallacy respecting the incompatibility of practical with scientific acquirements which has still too deep a hold on the English mind. There are, it may be too truly said, two classes of men, scientific men and practical men, and each has rather a contempt for the other. One of the great objects of Cambridge should be to blend the two, and to carry on science more into the range of practice. The university would thus administer more to the necessities of the age, would come into contact with real life, and would produce its legitimate effect in improving building and engineering, mechanics, agriculture, &c.

4359. Do you consider that you could combine sound theoretical teaching with practical applications in the university?—Yes, certainly.

4360. But do you think it is impossible for the university to turn out persons ready to enter the professions without further practical acquaintance with them, subsequently acquired?—I did not mean to say that, but that they might carry on the theoretic instruction in harmony with and into practical work, if there were more means of illustration. If there were more collections and models of engines, buildings, and ships, and things of that kind, by which the various professors could illustrate their lectures, and could show the application of their mathematics in this practical manner, I think that would fit the students to enter into the practical work of life much better.

4361. To what causes do you attribute the deficiency of which you have been speaking?—In the first place there are too few laboratories, and too little opportunity for experimental work; too little opportunity, that is, for the application of mathematical science. We have scarcely any philosophical apparatus, a thing which would be hardly credited. If we exclude the observatory there is none. I am glad to say that there is some improvement in prospect in that respect, owing to the important and munificent gift of our Chancellor. That is one of the first causes, that there is really no opportunity. I know men who have gone to Paris and elsewhere to see instruments, and to obtain practical knowledge. It is also much to be regretted that so little practical work is done by the resident graduates of Cambridge. I need not say in this room that there are brilliant exceptions, but the number engaged in practical work is singularly few.

4362. Do you consider the system of teaching too much isolated?—Yes. I consider that the Cambridge system moves too much in its own circle, and has too little relation with the world around.

4363. Not sufficiently influenced by what is going on in the world around?—Yes; I might observe perhaps that this opinion I hear expressed by many of the eminent men who come to Cambridge, and by none perhaps more distinctly and more strongly than by the astronomer royal, who I know feels very much the deficiency of Cambridge in this respect. I have asked the question of other eminent men, and they almost always agree in the remark that a great defect in Cambridge is that its mathematics have too little application and applicability.



4364. Do you consider that the work of teaching is confined too much to those brought up in Cambridge itself?—It is confined exclusively to those brought up in Cambridge, or almost exclusively so; very rarely is anyone employed as a teacher in Cambridge unless he is a Cambridge man.

4365. Will you now refer to the different classes of teaching?—The persons engaged in teaching are, in the first place, the college lecturers. Now the college lecturers as a general rule are, as one may express it, put on to teach; they are requested or directed by the head of the house to give lectures on certain subjects. They do not make it their avocation. It is of course to a certain extent their avocation, but their present position and their future interests are hardly at all influenced by it. Whether they lecture well or ill, they commonly do not advance themselves at all. The greater number of them are contemplating an entirely different kind of life, they are intending either to go to the bar or into the church; they are merely teaching as a temporary occupation in which they have not any great interest, and the result is that in many instances the college lectures are not what they ought to be, and fail to excite the interest which they might do in the students. My life has thrown me a great deal amongst undergraduates as well as other members of the University, and I find that the common expression is, "What is the use of going to college lectures? they do no good; we get nothing by them;" the remarks made are by no means complimentary. Moreover, it has to be borne in mind that those gentlemen are occupied merely in teaching the system in which they have been brought up, so that in thus leading others in the direction in which they have themselves gone, they do not really advance themselves much. Then the second class of teachers, and those who perhaps do the greatest real work in the university, are the private tutors. It has to be borne in mind that the object of the private tutor is to obtain a living, to be successful in training his men to pass and take high places in the examinations; and the result of those examinations is so important that they must be guided in their teaching exclusively, or almost exclusively, by the examinations. The third class of teachers are the professors, who, I think, do not exercise a legitimate influence in the university, which is partly because their teaching, to attract the students, must coincide and be regulated, or nearly so, by the examinations. If, therefore, a professor extends beyond the range of the examinations, he rarely obtains a class. I am aware that he does so in some instances, but in others it is notably not the case. There are certain highly eminent professors who have very small classes. One I might specially mention, the first man in his branch of science in Europe, who has hardly any students attending him, although the subject is a very important one in science. And here there is a great deficiency in our system of teaching, that is, that the professors, with the exception of myself, are without assistants, whose work it should especially be to connect the scientific teaching of the professors with the practical work of the laboratories, men who would act as demonstrators, and who would explain the practical application of that which is taught. That is a very grave defect in our university. Young men of that kind would be training for the higher posts of the university, and not only so, but the university would in this way constitute a school for the preparation of gentlemen to teach in various other schools of England. This would be an inducement to younger men to stay and devote themselves to science. I do not know that a more important addition could be made to Cambridge than that of a staff of young men acting under the professors, and associating the students with practical work.

4366. You trace, do you not, the deficiency of which you have been speaking in a considerable degree, though not exclusively, to the system of examinations?—Yes. Inasmuch as examinations must be the regulators of study, and peculiarly so in Cambridge,

because the rewards connected with the examinations are so high that a student preparing for his examination feels that he is preparing for his life prize, and therefore that he must devote himself entirely and exclusively to the subjects which are likely to be brought before him in the examination. Then it has to be remembered that the examinations are conducted and carried out almost exclusively by the persons who have been brought up in this system. I think that another very important addition to our university would be the obtaining the assistance of gentlemen as examiners who are distinguished in work in the world, not simply gentlemen who have formerly been at Cambridge, but those who have never been members of the university at all, distinguished men from various parts of the country, in order that new elements of thought and a wider range might be given to the study. This has already been done to a slight extent, and I am happy to say that here medicine and natural science have taken the lead. We have at present on our staff of examiners Dr. Hooker and Professor Flower in natural science, and Mr. Savory and Mr. Wood, two eminent London surgeons, in medicine and surgery. The importance of this is felt not simply by their being examiners, but the examiners at Cambridge are members of the various boards of studies, and therefore they are capable of exercising their influence through those boards, as well as directly through the examinations, and the gentlemen whom I have mentioned have already done so. There is no university regulation against this. It is quite open to any person to be appointed an examiner, but the effect really is, in mathematics especially, that the examiners are nominated mainly by the colleges in rotation, and each college therefore usually nominates some man of its own. Some are nominated by the senate, but with the exceptions which I have mentioned they have always hitherto been members of the university. I believe that Dr. Hooker was the first person not a member of the university appointed an examiner at Cambridge, and that is only two or three years ago.

4367. Do you think it is possible to call upon young men to go through examinations without pointing out to them with tolerable definiteness the character of the examinations that they will have to pass?—That must be done to some extent, but there is a danger of its being done too exactly. It then narrows the student's reading, and renders it dull. Reading for examination is not the best kind of reading, and the more one limits the subject, and the more definite and exact the groove, the worse becomes the effect of the examination upon the reading.

4368. Do you see any method of dispensing with the present system of examinations in its main features?—No, I do not.

4369. Do your remarks apply both to the examinations for ordinary degrees and for honours?—My remarks apply chiefly to examinations for honours. The examinations for ordinary degrees do not produce a very great effect. For my own part I wish sincerely that there were no such things. I have always earnestly protested against the existence of the poll degree or the poll examination at all. I think that to make that distinction at the commencement of an undergraduate's career, which it does, either that he is reading for honours or that he is not, is prejudicial, and that it would be better that they all should prepare for the honours examinations. Although all would not obtain honours, yet they should be passing along the same road with those who do. I think it would be far better that all should have the stimulus of honours before them, although it may be that they would not, in many cases, obtain them.

4370. Now will you be so good as to give the Commission your views as to the extent to which scholarships and fellowships are awarded?—The rewards of the university are of course most important. Indeed, one perhaps might say that with-

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30 Nov. 1870.



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out them the university would scarcely exist. They really are what has been described as the great forcing power of the place, and the character of the study is determined very much by them, and hitherto they have been given almost exclusively for distinction in certain subjects, namely, mathematics and classics.

4371-2. At Cambridge, the great majority study mathematics? The majority devote themselves to mathematics, still there are many classical men. There are some 400 fellowships, of which I believe about 40 are given annually, which is more than is really needed for the special subjects of mathematics and classics. Some might be abstracted from those subjects without detriment to them, and the giving of these to other branches of science would promote in a very great degree, perhaps more than in any other way, the study and the advance of those sciences in Cambridge. At present this is very little done. Only one fellowship has been given really and distinctly as a reward for science—that was within the last few months at Trinity College after an examination in natural science—and we do not know when there will be another. There is, therefore, much uncertainty about it. But if only one or two were offered annually, so that they could be calculated upon, the effect upon the study of science in Cambridge would be very considerable. The scholarships also are given almost exclusively for proficiency in classics and mathematics. There have at present been hardly any given to university students for proficiency in natural science; at Trinity College one is given annually, and at Downing College one is given occasionally. With those exceptions I think none are offered to undergraduates. Scholarships are offered by several colleges to gentlemen who have not become members of the university; these are called open scholarships. They are given in an increasing number, and they certainly operate well, and are drawing some very good men to our colleges. It is one of the bright points in connexion with natural science in the university, that there are some young men growing up, lately attracted to us, who I hope and think will do credit to the university.

4373. Should you wish to see science scholarships and science fellowships awarded without requiring any mathematical knowledge on the part of those who obtain them?—Mathematical knowledge, though a great advantage, should not be a *sine quâ non*. Before I leave the question of fellowships, I might observe that I think that the length of tenure is an evil. It makes the prize too valuable as a result of an examination at that period of life; it renders the strain of competition in the examination too severe, so that men not unfrequently break down under it, or seem to be exhausted after it. And moreover, a man having obtained one of those fellowships feels that he has done, as it were, his life's work, that he has attained the grand object for which he has been straining, and he is too apt then to rest upon his oars; he is indeed provided for for life, and definite courses, especially to the church, are then open before him, which render it unnecessary for him to pursue any branch of science, or rather divert him from science. A fellowship should place a man upon a vantage ground, but it should be a vantage ground for further work. If it terminated after 8 or 10 years, he would still be under the stimulus of further inducement to work. It would give him the opportunity to obtain a better position, would be a step on the ladder, but not the top of it. A fellowship for life should be a reward for subsequent efforts. If a man distinguished himself in Cambridge or elsewhere, then the fellowship should be made permanent, provided he continued his work in Cambridge. It should be a reward for distinction, and a means of attracting distinguished men to Cambridge. That is done to some extent already. I think, moreover, that a fellowship should be given without restriction. There should be no matrimonial bar. The prohibition against matrimony is a prohibition against nature, and we should be very unwilling to war

against the great laws of nature. One has to bear in mind also that it dries up and renders sterile some of the best blood of our country, which is no slight matter. I think, moreover, that a fellowship should be free from denominational restriction. I use the word "denominational" as distinguished from "religious." I have no desire that education should be separated from religion, but I do think that the rewards should be free from any denominational restriction.

4374. Do you see your way to attaching any conditions to fellowships which should have the effect of stimulating fellows to apply themselves more to work in the university?—My feeling would be that a fellowship should be an entirely open thing, that it should be given as a reward for high work done, and that there should be no bar of any kind whatever in connexion with it, and that the holder should be free to go where he likes and do what he chooses. A life fellowship should be associated with a residence in Cambridge.

4375. You would not like to see all the fellows required to remain in the university and apply themselves to university work?—No, I would let it be entirely open, that they should go into the world, and that it should indeed be just as I have said, a vantage ground for further work in the world or in Cambridge, leaving the world and Cambridge free to them. It would be in many instances a positive injury to a man to be obliged to reside in Cambridge, so much so that he would be better without a fellowship accompanied by such a restriction.

4376. When you speak of throwing the fellowships perfectly open, do you mean that you would give them to persons not educated at the university?—That is not quite my meaning. I mean that the terminable fellowships should be rewards for examinations in the university; the non-terminable fellowships I think might be open to all the world. It might be open to the colleges to select distinguished men from any quarter and grant them fellowships, provided they would do work in Cambridge; and I would desire that they should sometimes select men who had not had a Cambridge education.

4377. Have you any opinions to offer to the Commission respecting the heads of colleges?—I think that it is to be regretted that the highest prizes of the university, and which constitute some of the most desirable posts in the country, should be given with so little reference to distinction in the men who hold them, and with so little prospect of work to be done by them. This depends chiefly upon the mode of appointment to headships, which seems to me to be radically bad. The heads of houses are appointed by the fellows. The fellows, therefore, as a general rule, appoint the senior, and by appointing the senior every fellow gains a step. Now the senior is too often the man who has simply lived longest in Cambridge, and it would be a great improvement if the electors, the fellows of colleges, were not able to appoint one of their own body.

4378. How should you like to see the heads of colleges appointed?—I think that the fellows would make a very good selection if they could not appoint one of their own body, for of course the head of a house should be acceptable to the fellows, and I have no doubt they would sometimes select men eminent in science.

4379. Do you think that much work might be expected from the heads of colleges if they were appointed in a different manner?—I think that if they were appointed in consequence of being distinguished men, the energy which had made them so would continue to cause them to do more work. At present they are chiefly occupied in the business of the university. Many give a great deal of time and do valuable service to the university, but still when one bears in mind the number and the value of the appointments, I do not think there is an equivalent rendered.

4380. What are your views with respect to the length of the vacations?—That they are too long. I



would not make that remark with regard to the long vacation. It is a valuable period for private study and work, when the undergraduate can proceed unfettered and unhindered, his time not interrupted by lectures, and when he can devote himself to practical work in the museums or elsewhere, and it is long enough for him to arrange his plans and do it in a definite manner. Moreover, the long vacation affords an opportunity to some men to travel or enter upon some definite occupation or course of study. The long vacation, therefore, I would not interfere with, but the other vacations are too long, more especially the Christmas vacation, which averages six weeks. The time is determined by the colleges, which require the students to come up on a certain day, and they often rather throw impediments in the way of their coming up before or remaining beyond the time prescribed. The result is, that the professor's lectures must be regulated by the period at which the undergraduates are compelled to reside by the colleges. Practically, we are obliged to discontinue our lectures before the 10th of December, and it is very little use to begin before February. I have myself tried it, and have announced my lectures earlier, and the result was that the first part of the course was given to almost empty benches.

4381. (*Professor Stokes.*) You spoke of the vacations which you thought too long, and you said that you did not refer to the long vacation, the only other two are Christmas and Easter; would you consider the Easter vacation too long?—It is the Christmas vacation that I feel most strongly about.

4382. (*Chairman.*) Do you consider that athletics are attended to in a degree that is prejudicial to study?—I do not think that they are so prejudicial as is commonly supposed. The advantages accruing to physique, courage, and the development of manly character, more than compensate for the evils that attend them. I have had a very large acquaintance with undergraduates through a quarter of a century, and I have rarely known any seriously injured by boating or other athletics.

4383. Is it not the common view at Cambridge that they are now pushed to an extreme?—I think it is rather the view. We have to take into consideration, in connexion with athletics, not simply the persons who are occupied in them, but the stimulus to exertion, and the amusement it affords to those who are not. We must not forget an important feature in Cambridge life which is called "going down to the boats"; that is a run, and a joyous cheerful amusement for nearly the whole university, the effect of which is as important as upon those who are actually occupied in the boating, and is unattended with any evil. I do not mean to say that athletics do not divert some men from study—they do; but I think there must be an evil associated with every good; and if young men, especially young Englishmen, are to enter upon any amusement, they must and ought to do it heartily. The mere fact of their interest being engaged and occupied in something is beneficial to many of them. If their interests were not occupied in it they would be either unoccupied, or occupied in something worse. In speaking of Cambridge as a place of study, one ought not to leave out the social feature of college life, which is a very important element, and which certainly produces good effect upon character; it tones down asperities and calls forth decision and energy and good qualities; and on the whole I must say that I think the Cambridge undergraduates are remarkably well-behaved. We hear of their noise in the senate house: we hear now and then of their lamp breaking, and their being brought up by the police; but, on the whole, when we consider how many are collected together, it is a matter of astonishment how orderly they are, and certainly, in my relations with them as teacher, nothing can be more agreeable than their conduct uniformly is. I have never had the slightest annoyance from any student, and if there has been anything that called for correction, I have usually found it taken with good

feeling and thankfulness, so that I can speak in warm terms of their general good conduct.

4384. You would say generally that they are under the influence of good feeling and high principle?—Thoroughly so; and I would even go on to say (and my relations with the various classes of students have enabled me, perhaps better than any other man, to form an opinion on this point), that the morale of the university is better than is generally represented.

4385. An examination in natural science is now one of the special modes in which a young man, after having passed previously through the two general examinations, can obtain his degree?—Yes.

4386. Is not comparative anatomy and physiology one of those special branches of science in which there is an examination?—Yes.

4387. Have you any means of forming an opinion as to how that system is working?—I do not think that at present it produces much effect, it is incipient, it has only been a few years in operation. Probably in the course of time it will produce a good effect, but at present it is not very productive. I have known one or two who have been induced to follow science from it.

4388. The greater part of the candidates for degrees take one of the other special divisions, do they not?—Yes. I think that it would be productive of better effect if it were connected with the natural sciences tripos.

4389. You would have the same examination for all, and not one examination for pass men and another for honours?—Precisely so; but I should require a higher standard for a tripos. There are three classes in the tripos, and I would have other classes which were not honour classes.

4390. But the same papers set to all?—Yes, the same papers set to all.

4391. Can you give the Commission any information about the natural sciences tripos, how is it going on?—The natural sciences tripos has existed for 20 years, and it has not flourished so much as it ought to have done. The number of candidates has generally been about 12; this year there are more. The standard attained by the men is not very high. In the last two years only one has been thought worthy of being placed in a first class. Moreover, the candidates are chiefly medical students, who obtain some advantages in their medical course by passing through the natural sciences tripos, and are therefore attracted to that tripos rather by those advantages which they will obtain as medical students. I think that this comparative failure is owing, in the first place, to natural science not yet being an educational subject in the country to any great extent; so that of those who come to Cambridge very few have any grounding in it, and therefore they find the avenues to degrees more easy and natural to them by the other subjects, classics and mathematics; and they are also, if they are men of energy and application, far more certain of obtaining a reward by following those other courses. The route through the natural sciences tripos is at any rate an uncertain avenue to a fellowship. The feeling is growing in favour of natural science in the university and in the colleges; and I am always told by the fellows of colleges, "We will elect a natural science man if you produce a good one." But I answer, "We will produce a good one if you will offer the reward." It is rather expecting the cart to go without the horse, and that is our present position. One has great hopes from the better class of young natural science scholars who have recently come to Cambridge, that their distinction may be such that they will force their way through the barriers into fellowships, and the feeling certainly is increasing in favour of it. At only one college in the university at present is it admitted as a part of the regular college examination, that is St. John's, and I have very little doubt that St. John's will soon give scholarships and fellowships.

4392. There are a considerable number of subjects included in the natural sciences tripos; are the candi-

G. M.  
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30 Nov. 1870.



G. M.  
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30 Nov. 1870.

dates required to show a competent knowledge in all those branches, or only in a certain number of them?—It is preferred that they should show proficiency in two rather than in more, but there is no rule.

4393. I believe that for many years after the classical tripos was first established the number of candidates who presented themselves was comparatively small, but it has latterly greatly increased. Do you think that the same thing may possibly occur with respect to the natural sciences tripos?—I think it will, but the progress to it is slow, 20 years have already elapsed.

4394. Can you furnish the Commission with any recommendations which you think would have the effect of encouraging the development of the study of science in the university?—I think that, in the first place, there should be a great addition to our laboratories and working rooms for experimental physics, mechanics, and chemistry.

4395. With respect to philosophical apparatus, do you think that that is greatly wanting in the university?—There is none at all, and to what I have mentioned should be added engineering, architectural, and shipbuilding models, models and apparatus illustrative of the science of projectiles and gunnery, and other practical work. I state these things in a general way, that there should be means by which the studies of the place can be applied practically. My idea would be that those and other things of the like kind should be near the lecture rooms of the mathematical and physical professors, so that they could illustrate their lectures from them. There should be a staff of demonstrators or assistants to aid the professors in the practical application of their several branches of study; and there should be a more frequent addition to the boards of examiners of distinguished men who are not resident, the selection not being confined to members of the university.

4396. You have stated that the university has already in one or two cases taken steps in that direction?—Yes, I should also recommend a more liberal admission of science into the competition for college rewards, and especially such a combination of colleges as should ensure the offer of one or two fellowships annually to science. At the present time each college elects its fellows independently of every other college, and therefore there may be a distinguished student at one college which is rather averse to the study of natural science, and he would gain no reward. If all the colleges combined together they could without any difficulty whatever offer one, two, three, or more fellowships for science to the members of the university.

4397. The colleges do occasionally elect a fellow from another college, do they not?—Yes; but this is exceptional, so much so that I do not think it produces much effect; it cannot be regarded as a part of the system.

4398. The Oxford system, I believe, differs from the Cambridge in that respect?—I believe it does.

4399. Would those laboratories and working apparatus and models of which you have been speaking require a very large outlay of money?—Yes, they would.

4400. Without any buildings, but on the apparatus itself?—Yes. This is a great difficulty; our university is poor whilst the colleges are wealthy, but each college is a separate institution, and therefore there is great difficulty in getting the various colleges to combine for a common purpose. Preferring greatly spontaneous and voluntary action to anything compulsory, I have always longed for the time when the colleges should voluntarily do this, but the prospect of it is not very great, and I cannot help feeling that it will be necessary to apply pressure from without before it will be done.

4401. However, is it not the fact that within the last few weeks the colleges have taken a step which practically has the effect of placing at the disposal of the university a sum which previously the colleges applied to their own purposes?—That is the fact, but

the particular course which has been taken has been adopted partly because it was felt that it would be very difficult, if not impossible, to bring the colleges to a combination in any other way. In fact, the consent of the colleges has not been given to this; in this instance it was done by the action of the heads, and it was felt that to bring the machinery of the various colleges into harmonious operation would take so long a time that it would be almost negating, which they were most anxious not to do, the liberal offer which had been made by the Chancellor.

4402. The practical result was, that it placed at the disposal of the university a fund of from 1,000*l.* to 1,200*l.* a year, in addition to its previous income?—It did so, which will very soon be absorbed.

4403. Will you be so good now as to state to the Commission what was the original object of the professorship which you hold?—It was founded 170 years ago, and the object of it was to teach anatomy as then understood, which included the whole science of anatomy and physiology at that time. During that period the range of science has very greatly increased, and at the present time my professorship is flanked by the professorship of zoology and comparative anatomy, and within the last few months Trinity College has taken the very important step of founding a prælectorship of physiology, which is one of the most hopeful things that have lately taken place in our university, and which is commencing in a successful manner.

4404. What is the stipend attached to your professorship?—300*l.* a year, and in addition to that there is a dividend of about 30*l.* or 40*l.*, from students' fees, which are paid to common professorial fund, and the fees from my class, which amount to about 100*l.*, one portion of which I pay to my demonstrator. The stipend and fees together amount to about 400*l.*

4405. The university provides you with a demonstrator, does it not?—Yes, who is paid 100*l.* a year. I have extended the course of instruction since his appointment; he shares some of the duties with me.

4406. He is appointed by yourself, is he not?—Yes, he is appointed by myself, with the sanction of the vice-chancellor.

4407. Your professorship is connected, is it not, both with natural science and with medical science?—The professor of anatomy is expected to take the department of human anatomy, and one course at least of his lectures is to be suitable for students of natural science. This is a very important point, for it makes my professorship what it ought to be, a connecting link between the science of the university and practical medicine.

4408. I think you have already stated that most of those young men who attend your natural science course of lectures do so with a view of ultimately taking degrees?—Yes, a large number do.

4409. Do any attend the lectures without any view to taking honours or to taking their degree, but merely from having a natural liking for the subject?—Yes, a few do, but not many.

4410. What provision has the university made in the way of museums and rooms for the study of comparative anatomy and human anatomy?—There are two buildings, both of which are more or less under my charge. There is, in the first place, a part of the new museums, in which is the museum of comparative anatomy, which is fairly provided and very convenient for the practical working purposes of the students, and which is daily increasing. Connected with it there is a superintendent who receives a stipend of 100*l.* a year, and that gentleman pays an assistant dissector.

4411. Is there sufficient space around the museum for future additions?—There is considerable space.

4412. Are the buildings so constructed as to be capable of addition?—Yes.

4413. Is there vacant space adjoining them?—Yes.

4414. This museum has been built, has it not, within the last 10 or 12 years?—Yes. There is a very good lecture room and a private room for myself,



a superintendent's room, and an articulator's room; but there is still need of rooms for the dissection of large animals and experiments upon animals, for the assistant dissector, for the students' dissections, and for microscopic work. I think also that in connection with a building of that kind in the university there ought to be a library containing the best anatomical works, and especially books of plates, so that the students may see the originals from which their hand books are supplied, and be able to refer to original sources. In a room of that kind examinations could be held for natural science, also meetings of societies.

4415. Is there sufficient space at present for those objects?—There is ground room, but not any space in the actual building.

4416. Do you think that a special library is required independent of the university library?—I think there ought to be a library to which the students could readily have access in connexion with their work; the dissecting room, the museum, and the library should be in close connexion with one another.

4417. I presume that the university library contains such works as those you have been speaking of?—It contains most of them. There ought to be a demonstrator or teacher of practical comparative anatomy.

4418. Under your direction?—Under the direction of the professor of zoology and comparative anatomy and myself. I have always made it a great point that the professor of anatomy should have a position in that which may be perhaps called the science part of the building. I have always felt that there are principles involved in it, that a Cambridge professor of anatomy ought not to be regarded as a mere teacher of practical anatomy, to prepare students for medicine, but that his duty should be to bring the practical apparatus of medicine into relation with science and scientific anatomy.

4419. Is it proposed that the new prælectorship of Trinity should be in any way connected with your professorship?—He is appointed entirely by the college, and the college therefore can regulate his proceedings exclusively of the university; but the students of the university have a right, I believe, to attend his lectures. At the present time his laboratory is in a building in the new museum, and he is therefore using a university building, and I feel it very important that that relation should continue to exist, that the teaching of physiology should be in close connexion with the teaching of the other branches of natural science. It economizes the time of the students, and is a great advantage to the professors and teachers, who can assist one another and mutually co-operate.

4420. Is it proposed that there should be any mutual arrangement with the holder of the prælectorship, with respect to the respective courses of lectures?—No, there is merely a private arrangement; the university would have no power to arrange the courses of lectures of the prælector. I have spoken hitherto of the building appropriated to zoology and comparative anatomy; there is also a building appropriated to human anatomy which is the original anatomical building of the university, and which, to my regret, is separate from the other. In it there is a good dissecting-room fairly supplied with subjects.

4421. That is where Professor Clark used to lecture, is it not?—Yes; there is also a lecture room devoted to practical anatomy, and a museum of human anatomy and pathology. There is a private room which is used by the demonstrator, and serves for the practical microscopic class. The Regius professor uses this building and the specimens in the museum.

4422. Perhaps there are other more pressing requirements of the university than additions to this museum?—Yes. The additions I have mentioned to comparative anatomy are, I think, very important to the study of that branch of science.

4423. Will you be so good as to state to the Commission how many courses of lectures and demonstrations you are in the habit of delivering?—I give a course of 50 lectures on anatomy and physiology in the new museums; these are intended for students of natural science as well as medical students. In that course I examine the students every day for the first ten minutes of the lecture, making a *résumé* of the previous lecture, and I give written examinations two or three in each term. There is a microscopical demonstration once in a fortnight, and a practical microscopic class once in a week, where each student is instructed in examining and preparing specimens by a gentleman who has lately obtained one of the scholarships of Christ's College, and who is paid by me for the purpose. I give also, in conjunction with the demonstrator of anatomy, a course of practical lectures on anatomy in the human anatomy museum amounting to about 60, and the demonstrator and myself superintend the dissection by the students. It is of course a question whether there should be a medical school in Cambridge at all; but a medical school is one of the means by which the science of the university may be brought into relation with practice, that is to say, a means by which scientific teaching may be carried on into the more directly practical part of medical study. That should be the work of a medical school in Cambridge, not to profess to fit the students fully for the actual practice of medicine, but rather to introduce them to it, and that may be done well in Cambridge. In the hospital and in the staff of teachers there are sufficient accessories to do that well; to attempt more than that would be a mistake; but in order that this should be done well, it is important that the professors in the medical school should be selected with reference to scientific attainments; that they should not be selected, as is too apt to be the case, simply from the gentlemen who happen to be practising in Cambridge. All our students ought to be obliged to resort to the metropolitan hospitals and schools for at least two or three years of their time.

The capabilities of Cambridge for promoting science and scientific education in the country are very great, and might, by a little effort and judicious arrangement, be turned to much greater account than they now are. The disposition to do this is daily increasing in the University, interest in science is growing, and such assistance or even compulsion from without as is requisite would be hailed with pleasure by many of the residents.

4424. (*Dr. Sharpey.*) Adverting to a statement which you made at the commencement of your evidence, with regard to the importance of giving to the study and teaching in Cambridge a more practical direction, you have already explained yourself as regards the direction towards medicine, but would you contemplate also having special teaching in such technical subjects as engineering, for example, or mining, or civil or naval architecture; would you actually undertake instruction in those subjects at Cambridge, or would you merely refer to them as an illustration of the value of the application of pure science?—Chiefly that.

4425. That is to say, that a professor who gave a systematic course in any branch of science, we will say physics, should show the applications of it in its different directions?—That is what I mean.

4426. You would not contemplate the establishment of a school of engineering, or any of those technical subjects?—That is not at present my idea. I do not mean to say that such might not be done in the course of time, but I did not mean that.

4427. With regard to the difficulties met with by students in working for the examinations, I think you said that if you point out the subjects too specifically, men are induced to work in a groove, in which I perfectly agree with you; but on the other hand how could that be remedied, because if you do not specify any particular subjects, is not the study apt to be too broad and too shallow?—The difficulty

G. M.  
Humphry, Esq.  
M.D., F.R.S.  
30 Nov. 1870.



G. M.  
Humphry, Esq.,  
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is, in that as in all other instances, to hit the happy medium. I think at present it is in too narrow a groove, or rather in a groove of not sufficient application, too much in the groove of pure science.

4428. How would it do to give an option to the student to take up particular branches, because then you would not force him into a particular groove?—That is done to some extent, but not sufficiently, I think.

4429. The students would often prefer to do that, would they not, if they had not a dread of an examination impending over them?—Perhaps so, but that is to be regulated by the questions very much; at present the questions are set exclusively by those who have already gone through the examination, and therefore present too much sameness.

4430. Have you thought of a remedy for that?—The only remedy that I have thought of is adding to the staff of examiners men who have been into the world and seen more of the application of mathematics to the various subjects of science.

4431. Would you allow candidates to obtain a degree in Cambridge upon science alone who had had no literary culture?—No; I think that a certain amount of literary culture is a necessary engine to work with.

4432. To what extent would you say that Latin, Greek, or modern languages should be required?—I would require a certain amount of language knowledge. I do not myself feel that language knowledge is to be obtained specially through any one particular medium.

4433. Looking to the prospective improvement of the endowed schools throughout the country, do you think that a well-trained young man coming up from one of those schools, and a fair specimen of the training of those schools, might be prepared to enter upon the Cambridge studies without taking up literature at all, that is to say, without taking up Greek or any of the languages, and to go on with science?—Yes, certainly, a great many are so, and it is to be regretted that when they come to Cambridge, if they have the qualification, they should not be allowed at once to enter upon science.

4434. Would you test that by an examination in Cambridge, or would you think it preferable that there should be a final examination at a school to attest the young man's fitness, that he should come up with a certificate, analogous to what the Germans call *abiturienten-examen*?—I do not think really that it would make much difference, provided the university had an assurance of the sufficiency of the examination.

4435. (*Professor Stokes.*) Is it not the case that of late years several colleges have combined together for the purpose of college lectures?—Yes, they have.

4436. Do you not think that that has a tendency to improve the character of the college lectures, partly by rendering the classes more homogeneous and partly by affording a greater stimulus to the lecturers?—Yes, I think it is an improvement, but that it would have been better if the combination had been wider, and if the university had been taken more into consideration. For instance, Trinity and St. John's combine, St. John's to teach chemistry, and Trinity to teach physics. I think it would have been better if they had combined in the university with the Professor Liveing and with the professor of physics to teach physics and chemistry to the whole of the university. At present there is a loss of power in our colleges, owing to the want of arrangement and co-operation with the university. There is a chemical laboratory at Downing, another at Sidney, and a third at St. John's. There are therefore four chemical laboratories in the university, neither of which is efficient and neither of which is properly staffed. If they had all been combined together into one laboratory, with half the staff there would have been a much more efficient mode of teaching. I regret much to see the system growing up in the colleges in that sort of way.

4437. But still you think that the combination, as

far as it has gone, has been beneficial?—It is so recent that it hardly has had much effect at present, but I should conceive that it would be an important step in the right direction, especially as I hope that they will soon supplement it by a combination for the purpose of giving rewards.

4438. You have expressed an opinion in favour of the introduction of examiners from without; are the Commissioners to understand that you have in view what I may call the staple subjects of Cambridge, classics and mathematics, or only those which are studied there less generally?—I include the staple subjects of classics and mathematics.

4439. Did I understand you rightly to say that you are in favour of abolishing altogether the ordinary degree, and obliging everyone to choose some particular tripos, and to study for that, and to show a certain amount of mediocrity as a qualification for a degree?—Yes.

4440. And I think I understand you to say that you would set before every student an examination paper containing questions for the highest man in the department?—Yes; I would set before him a paper containing various questions, as is at present done in the mathematical tripos; there is a preliminary examination for the tripos in which the questions are of a lower standard; I see no reason against making those questions come within the range of the lower class of men. I would not at all lower the standard of the tripos, but would append to it other classes, in the hope that all who strove for a place would have the ambition of the higher classes before them.

4441. Would you be in favour of splitting each tripos into two parts, in the manner in which the mathematical tripos is now split, and allowing a man to get his degree on the strength of passing the lower examination?—That would be one mode of doing it, but I have no especial feeling in favour of that one mode.

4442. Do you not think that at present, with the mathematical tripos there is a considerable amount of mathematical knowledge required in order that a man should get his degree on the strength of mathematics alone; is the amount too great to require from a mere pass-man?—Certainly, the present examination gives him a degree as an honour man. I would not require so high a standard as that for an ordinary degree, but that the examination should be the same in substance, the standard being different, my object being that each man as he passes through the Cambridge course should have honours before him.

4443. But do not you think that there are many men whose object and ambition would be simply to get through?—Certainly, but I think that there are also many whose ambition would rise higher. The triposes would operate upon a larger class than they now do.

4444. Are you of opinion that what I may call a one-sided course of reading is a good course for a man who, at the outside, will attain only mediocrity in that department?—I think that they would attain to greater knowledge in the one department than they now do. At present it is such a very moderate amount of knowledge that is required in the several departments. An ordinary degree man has to get up a certain amount of ten or a dozen subjects, whereas an honour man gets up one only.

4445. After having passed a qualifying examination in the others?—Yes; they all pass the same qualifying examination, but then the one set of men take up a number of subjects, whereas the other devote themselves more especially to one. I think it would be better if they all took the latter line, and having shown a fair groundwork of knowledge, they would then be rather induced to pursue some separate subject by the honours before them.

4446. You spoke of one fellowship which had recently been given for eminence in the natural sciences at Trinity College. I have in my mind the case of a fellow who I presume was elected for eminence in that department, although not, I imagine, at a special



examination, and perhaps there may be other cases in the university which I do not at this moment think of?—There have been three who have been elected to fellowships partly because they were eminent in natural science. It was taken in conjunction with other things; but the Trinity fellowship is the only one which has been distinctly awarded for eminence in natural science.

4447. You stated that you thought it would be desirable that different colleges should combine to give a fellowship for we will say natural science; how would you carry that out, would you have a special examination after the degree examination?—No, that would not be necessary. If the 17 colleges arranged amongst themselves that from one or the other every year one or two fellowships should be given to those who stood first in the natural science tripos, provided they deserved it, I think it might be done without any great difficulty. I wish, for instance, that it should be known definitely beforehand that in the year 1871 there will be two fellowships for natural science, and in the year 1872 the same, and that could only be done by several colleges combining and agreeing to do it. Emanuel might say, we will give a fellowship in 1872, St. John's in 1873, Trinity in 1874, and so on.

4448. But no obstacle exists at present to the election by any college of a fellow for eminence in natural science?—That is quite true; but a candidate of natural science has no assurance that if he does well he will be really elected.

4449. There is no such assurance in the case of classics or mathematics, except the custom of the place, at present?—No; but the custom of the place does give the assurance which it does not give in natural science.

4450. Because those studies have won their way, and the natural sciences have yet to do so?—Quite so; but the natural sciences would win their way much more quickly, and without real detriment to the other sciences, if the plan I have indicated were adopted.

4451. (*Sir J. P. Kay-Shuttleworth.*) With regard to preparatory instruction, are you able to give the Commission any suggestions as to the branches of scientific studies in the endowed schools and public schools which you think would be most useful to young men intending to come to the university?—The branches of study which are fundamental to others, such as physics and chemistry; persons who are intending to devote themselves to natural science should obtain as a basis a knowledge of the fundamental properties of matter.

4452. The previous preparation in those studies would, in your opinion, increase the number of students who were disposed to enter upon a course of scientific culture in the university?—Very much.

4453. With regard to the examinations, has it ever occurred to you that the scientific examinations might be modified by trials in manipulation, in observation, and in experiment, and generally in phenomenal illustration?—That is already a part of the examination at Cambridge. The chemistry student is taken into the laboratory, and in anatomy the student is required to dissect or to describe specimens, and in botany likewise, and geology, mineralogy, comparative anatomy, and in fact in all branches of natural science.

4454. Is that extended to experimental physics?—At present I am afraid we hardly have experimental physics. Experimental physics is at present not separated; it is about to be so, I am happy to say.

4455. Is it extended to optics and astronomy?—I believe not.

4456. You would think it desirable that it should be extended to all the branches of experimental physics?—Very important.

4457. You have expressed your opinion on the importance of assistant professors or demonstrators aiding the professors in their teaching of natural science. Would you think it desirable that there should be in the university a sort of graduated professoriate, as, for example, an eminent professor who

would give part of his time to research, and an assistant professor and probably a demonstrator connected with each of the chairs?—That would be most important, that is to say, the greater the number that we can involve in the work of science teaching the better, under whatever form or name.

4458. Have you thought from what sources in the university you could derive funds for such a graduated professoriate?—We have no sufficient funds in the university. The only source from which they could be obtained in Cambridge is from the colleges.

4459. Could you accomplish that, by taking a certain portion of the funds of the fellowships, either by limiting the time or limiting the amount of the endowment of each fellowship, or by applying the fellowship itself to the object which you have adverted to?—I conceive that the best plan would be to draw a certain proportion from the common college funds for those purposes, and leave the remainder to be appropriated to the payment of the members of the college, as fellows, scholars, and so on.

4460. Having derived something from the common college fund, you would leave the college itself to determine the appropriation of the remainder to fellowships and other purposes?—Under certain restrictions I would.

4461. Did I rightly understand you to say that you do not expect that the colleges would make such extensive changes in the application of their funds without some external pressure?—I fear that they would not.

4462. Have you formed for yourself any idea of the nature of the power that should be brought to bear in this way upon the colleges?—It can only be the power of the nation by legislation.

4463. The tendency of your suggestion, therefore, is to increase very greatly the power and efficiency of the university instruction, and to render the colleges in that respect contributory to the university instruction?—Quite so.

4464. Have you formed any definite idea, with respect to scientific culture, what the function of the college should be as compared with the function of the university?—The function of the college in scientific culture at present I do not think need go much beyond that of furnishing the funds for the university instruction, and furnishing the rewards to be obtained for that instruction upon examination.

4465. Might there not perhaps be some useful connexion between the college and the professorial instruction in the way of preparatory tuition or repetition, as for example, if the demonstrator of a professor were likewise a tutor in a college, or a sub-tutor in a college?—I think that the combination would hardly work. The numbers whom we can expect to study science in each individual college cannot be very great at present, and they are better collected into one university school.

4466. You would expect one source of the increase of the number of students of science in the university to be the better preparation in the public and endowed and other schools?—Yes, certainly.

4467. And another would be the diversion of the rewards of the university from their too exclusive appropriation to classics and mathematics?—There would be three sources, first, the one that you mentioned, the better preparation in the endowed schools, secondly, the better instruction in the university, and thirdly, the different appropriation of the rewards.

4468. Supposing a man to have had a good preparation, literary and scientific, in an efficient endowed school, and to have obtained there, or from some public board, satisfactory testimonials, would you admit him in the first instance to a sufficient literary examination in the university, so that if he passed it he might devote his whole time to scientific culture?—I would admit him to such examination in the university under any circumstances, provided he proved to the university that he had a sufficient basis of general knowledge. I would then allow him at once to proceed with his scientific studies.

G. M.  
Humphry, Esq.,  
M.D., F.R.S.  
30 Nov. 1870.



G. M.  
Humphry, Esq.,  
M.D., F.R.S.  
30 Nov. 1870.

4469. You would permit him to offer himself for such examination without rendering it obligatory upon all students?—I think that the university should have an assurance in some way or other that the student offering himself has competent general knowledge.

4470. And such an examination in the university would be a sufficient assurance?—Yes.

4471. Then having admitted him through that gate into the studies of the university, if he were disposed to devote himself thenceforth purely to scientific culture, would you put any impediment in his way?—Certainly not.

4472. You would admit him to a scholarship in the first instance if he could obtain one by merit, and afterwards, having obtained honours, to a fellowship?—Yes.

4473. After that would you admit him into the government of the university?—Yes, certainly.

4474. At present I understand you to be of opinion that the instruction in the university is almost sterile in its practical consequences in the cultivation of science, or even in its contribution to the practical work of life?—I do not go so far as that, but I think it is more sterile than it ought to be; it ought to be more productive. I would not say that it is sterile, because the cultivation and training of the mind in any way can hardly be considered sterile.

4475. But does it lead as one consequence to much future scientific reading?—Not nearly so much as it might do and ought to do.

4476. Do many of the students who are engaged in the ordinary course of training at the university enter into the practical scientific professions as a consequence of their training; do they go into engineering, or into purely scientific pursuits?—I am afraid not a very great many. That is a direction in which I should like to see our education extended.

4477. What is the tendency of the education in Cambridge upon classes of men who like the clergy are afterwards to devote their lives to a separate profession; do they afterwards combine in any very great degree scientific reading or scientific pursuits with their own profession?—Not very much, I think. I do not see that that is especially desirable. I think that in the education of a clergyman you should endeavour so to train his mind and give him a free power of thought as to enable him to deal with the subject which is then brought before him.

4478. But you would think it desirable that he should keep pace in reading with the general progress of science?—In general reading, but I do not know that a knowledge of science would be more necessary to a clergyman than a knowledge of theology would be to a scientific man.

4479. Are you of opinion that it would be important that the laboratories should be more university than collegiate laboratories, and the museums also?—Yes.

4480. That they should not be simply accessible to students, but should be under the general university government?—Yes.

4481. That in fact there should be a unity of design and action in the scientific culture of the university, tending to a common result?—Certainly.

4482. So that you would then expect a much larger amount and a greater degree of efficiency in the scientific culture than by the separate action of the colleges, or even by their combined action in any smaller sphere?—Yes.

4483. (*Mr. Samuelson.*) Is the matriculation examination at Cambridge a college or a university examination?—There is no matriculation examination. There is no examination at entrance into the university. The preliminary examination in education is after a student has been a member of the university for two or more terms.

4484. (*Chairman.*) Some of the colleges have private matriculation examinations of their own, have they not?—Yes, some few have; Trinity College has.

4485. (*Mr. Samuelson.*) But the college examinations are not universal, there is not an entrance examination in every college?—No.

4486. You have stated that you would like the mathematical teaching at Cambridge to be to a greater extent preparatory to active life. Can you give any instances of other universities, either in this country or abroad, where the mathematical teaching is of that character?—I am not very much acquainted with the working of other universities.

4487. But you are quite clear, I presume, in your own mind that there would be no difficulty in making it so?—I do not think there would be any, and persons better able than I to judge are of the same opinion.

4488. You have also spoken of the assumption of the incompatibility of practice and science?—I have spoken of the very injurious effect of such ideas.

4489. But is there not an incompatibility in this sense, that it is difficult for a young man to acquire much practice and much science before the time when he must devote himself to the active duties of life?—I think as far as he is instructed it might be in both.

4490. What I meant was that he has only a certain number of years to devote to education, and that there is a difficulty in combining the practical and the scientific education within that time?—I think that the time is sufficient for the combination of the two, and that the culture is rather too high in one direction, and that it would be better if it were less in the one direction and rather more in both.

4491. In stating that opinion do you base it in some measure upon the subject with which you have principally to deal, namely, the subject of medicine?—No; I base it rather upon my knowledge as far as it goes of what the mathematical examinations are, and my observation of the men who have passed through them.

4492. But if it should be the case that in engineering, for instance, and in construction generally, it is desirable that youths should acquire practical knowledge whilst they are youths, does not that throw some difficulty in the way of the combined education which you would like to see given at a place like Cambridge?—I think that combined education might be given in this way, that when a professor is teaching a certain branch, say of mechanics, he should show the application of his principles in the construction of a house, or an engine, or a ship, and that he should have a house, engine, ship, or model before him to elucidate his teaching.

4493. But do you think that that is a sufficient substitute for the pupilage which is now usual in those branches?—That I think is quite a different thing. I think he must have that pupilage in addition for actual practical work as a mechanic, but that in this sort of way his thoughts would be directed to the practical work while he was pursuing the theoretic.

4494. But if the necessities of his profession and his career require that he should receive that practical teaching before a certain somewhat low limit of age, how then would you combine the two?—I would not propose to combine that kind of teaching; for instance, a student learning mechanics might have his teaching of mechanics explained by a steam engine, but that would not at all enable him to make an engine, to do the actual practical work of making the nails and hammering the rivets, and so on. The students who are to be brought up as engineers usually spend a great deal of time, and as far as I have a little knowledge of them too much time, in actually making and hammering rivets, and so on.

4495. At what period of his life would you expect a young man to get his practical knowledge?—That might be done either before or afterwards. I am not proposing that he necessarily would ever get that exact knowledge at Cambridge, and I suppose that it is not an essential preparation for a master builder that much time should be devoted to the actual manual work of machine making. My idea is that Cambridge should teach him rather the principle of the construc-



tion of a rivet, and the mechanical powers and processes, and the mechanical knowledge should be illustrated by the rivet and by the engine; but the mode of making either is a different thing, and I do not think that that need come within the course of university education.

4496. Then in point of fact you would not make the university a technical school?—No, I think not. I am scarcely prepared to say that.

4497. And if for the purpose of any profession that technical knowledge should be necessary, then the mere university teaching, so far, would not give it?—There might be some instances in which it could be done, for instance, in chemistry theory and technical teaching are combined, and in medicine to a certain extent theory and technical teaching are combined, but I should fear that the technical teaching of engineering would be very difficult to teach in Cambridge. I do not mean to say that it is impossible, but we have no provision for it. I do not contemplate extending it to that quite.

4498. Taking the application of chemistry to the arts, you would teach that?—Yes, to a certain extent.

4499. You would teach, for instance, the chemistry of dyeing especially?—Yes, certainly.

4500. With regard to the want of application of the studies to the business of active life, is that want felt to any great extent by the undergraduates themselves?—I have heard several mention the want of it.

4501. Do you think that the undergraduates would be more assiduous if a more practical turn were given to their studies?—Yes, more interested in them, and we should attract then a larger class of those men who are proposing to enter into practical life.

4502. Notwithstanding certain drawbacks incidental to the university in reference to professional education?—Yes, certainly.

4503. Has the competition for science scholarships been very intense?—Yes, in some instances, and they have been obtained by men of considerable power.

4504. Have the competitors been tolerably numerous?—No, I do not say that. There has been rather a deficiency. Not a few of the scholarships have been not awarded for want of sufficiently good competitors.

4505. So that there is some foundation for the argument of those who would like to adhere to the old state of things, that the number of persons competing is very limited as yet?—Yes. Most of the science scholarships are what we call open scholarships, that is, scholarships which are given to students before they have become members of the university, which competition is a test rather of the teaching in the schools, and shows a want of that teaching, because several scholarships have not been awarded in consequence of there not being fitting candidates.

4506. In fact until science is better taught in the schools it would not be of much use to increase the number of scholarships?—I think the number of open scholarships, as we call them, is really sufficient, but the number of scholarships awarded in the university is insufficient.

4507. What is the relative proportion of open scholarships and scholarships for university students in reference to science?—In reference to science there is only one scholarship for university students, and that is the scholarship at Trinity College. One has been offered by Downing College to the University, but I am not sure that the offer is repeated.

4508. Are the open scholarships not also available for the university students?—No, they are for students who have not yet entered the university. They are open to all the world to induce students to become undergraduates, but not open to those who are undergraduates.

4509–12. Are the men who come up to those open scholarships generally men who have just left school?—Some are men who have just left school. The better class of men are those who have gone through an

additional education, either in the School of Mines, University College, King's College, or some other place.

4513. You have said that you thought that the study of theology was a better preparation for a clergyman than the study of science, but is it not the case that fellowships are not granted for proficiency in theology?—Fellowships are granted simply for proficiency in classics and mathematics.

4514. Do you think it would be a bad thing if some clergymen had obtained their fellowships, and consequently their college livings, rather for proficiency in science than for proficiency in classics and mathematics?—I think it would be an exceedingly good thing.

4515. That there should be a large infusion of scientific knowledge amongst the parochial clergy?—Yes, certainly. I meant that one could not regard a large amount of scientific knowledge as a necessary qualification for a clergyman.

4516. But you would think it by no means a bad thing that some fellows who subsequently became clergymen should have obtained their fellowships for their proficiency in natural science?—No, it would be an exceedingly good thing.

4517. You have stated, have you not, that you thought that some outside pressure might require to be brought upon the colleges before they would contribute largely from their funds to the promotion of natural science?—I fear that it must be so.

4518. But is it simply that they require pressure, or is it that they require powers which they do not now possess?—There is nothing to prevent them contributing to a common fund to the extent of five per cent. upon their distributable income, provided they agreed to do so. There is no real difficulty in that way of doing it.

4519. With the consent of the Privy Council could they all obtain the necessary power to contribute to a common fund for university purposes?—Yes; the difficulty is to induce them to combine for the purpose.

4520. (*Sir John Lubbock.*) Did I rightly understand you to say, in answer to Sir James Kay-Shuttleworth just now, that, in your opinion, a general knowledge of science was not more necessary to clergymen than that of theology was to scientific men?—I think that one cannot expect either a clergyman to have any extensive knowledge of science, or a scientific man to have an extensive knowledge of theology, that is what I meant; you cannot expect either to have a great amount of both.

4521. I suppose you are speaking of scientific men rather as instructors than as discoverers: but a very small proportion of scientific men are engaged in general tuition, and as far as they are occupied in the prosecution of research, a knowledge of theology is not particularly necessary for them?—No, I think not.

4522. On the other hand, clergymen are almost all engaged in general tuition, therefore there is a difference between the two, is there not?—Of course. I was speaking of their special duties as clergymen rather than of their functions as general teachers.

4523. From that point of view, would you not consider that, so far as they are engaged in tuition, a knowledge of science is very desirable in the clergy?—A knowledge of science, as a knowledge of letters or a knowledge of mathematics, is I think a very desirable basis for a clergyman.

4524. Those who are engaged in the work of tuition require a more general culture than those who are engaged in the special application of study, either to the purposes of professional occupation, or to that of research?—For such teaching general culture is most important.

4525. But clergymen are teachers in 99 cases out of 100, are they not?—General teaching is often one of their duties, but it does not necessarily form part of their duties.

G. M.  
*Humphry, Esq.,*  
M.D., F.R.S.

30 Nov. 1870.



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30 Nov. 1870.

4526. And being engaged in tuition, you would consider a general knowledge of science more important to them than a special knowledge of theology is to

scientific men?—Yes; persons engaged in tuition require more general knowledge than those who are not.

The witness withdrew.

G. D. Living,  
Esq., M.A.

GEORGE DOWNING LIVING, Esq., M.A., examined.

4527. You are Professor of Chemistry in the University of Cambridge, are you not?—I am.

4528. Can you give the Commission any information as to the results that have hitherto been obtained from scientific teaching in public schools?—I think that the results, so far as I have seen, are very small indeed compared with the noise which has been made about them. I have examined a great many boys directly from the schools, both at the schools and at various examinations, and I think that the results on the whole are very small indeed.

4529. Have any *bonâ fide* exertions been made by the schools, or has what has been done been merely to meet public objections to the want of scientific teaching?—I think that something has been done of a *bonâ fide* character, but I think that the schoolmasters are often a little at a loss as to what should be done. The heads of schools do not themselves know what could be well taught, and they have some difficulty in finding teachers. I think that on both those heads they have rather failed.

4530. Whence has your experience of the scientific teaching of schools been derived?—Partly from examining some of the larger schools: the Birmingham school for instance I have examined repeatedly, and several other schools occasionally; and I have always examined for some time past under the Council of Military Education for admission to the military colleges and for direct commissions, so that a good many of those who have been candidates for those colleges and for commissions have come under my observation.

4531. What opinion have you formed as to the influence of competitive examinations?—On the whole I think they have given a considerable stimulus to the study of science in the schools; they have been prominently put forward in the programme of the different competitive examinations, and schoolmasters have been almost obliged to introduce something of the kind into their schools. I think that they originated the science department in Cheltenham College, which has been a tolerably successful one, and they have originated it in some other schools.

4532. What value do you attach to the examination test?—I think that in the first place it is almost the only test in the perfect honesty of which the public have any confidence. They believe that it can be carried out honestly because they have seen it so done at the old universities for some time past where the rewards are given with perfect fairness, and no one doubts that the test is applied with honesty. I do not think that they believe in any other test being applied with anything like equal honesty, but at the same time it is not of course a perfect or a complete test.

4533. Do you see any defects inherent in the examination test from which it is impossible to relieve it?—Of course there is the advantage which it holds out to those who have undergone special preparation. I think that is one of the defects which is almost necessarily inherent in it, and makes it a little unfair to those who have not had the same advantages; but the advantage obtained by special preparation diminishes in proportion as the competitors are generally well taught: it is amongst those who are indifferently trained that special preparation tells most. Another thing which renders it perhaps less valuable as a test is, that it tests so much more certain qualities than others. It will test very well a knowledge of general principles, accuracy, readiness, and originality, and if it is sufficiently extended it may test of course the extent of knowledge, and indirectly industry and so on; but it can hardly test other points in the characters of the competitors which may be equally

important to be tested. It is also difficult to make a fair comparison between knowledge of different kinds.

4534. But it would be difficult, would it not, to substitute any other test in the place of the examination test?—I do not know of any other which is as good on the whole.

4535. Some of the open scholarships in Cambridge are now awarded, are they not, for proficiency in science?—Yes, at several of the colleges.

4536. Have you any experience of the examinations for those scholarships?—Yes; I have examined sometimes for one college and sometimes for another.

4537. Are the results tolerably satisfactory?—Not on the whole; sometimes we have very good candidates, but at other times the candidates have been so ill prepared that it has been found impossible to award the scholarships.

4538. Any young man entering the university who has made tolerable proficiency in science would be almost sure of obtaining a scholarship, would he not?—I think he would, at one college or another; as the competition is so limited at present.

4539. Can you furnish the Commission with any information as to the opportunities which a man now has for studying science in Cambridge?—This will come under two principal heads: first, the staff of teachers, and secondly, the other appliances for learning. The teachers at Cambridge are of two kinds. There are first of all the university professors. They hardly adequately represent all branches of science, but seem to have been chosen in the first instance to represent particular branches, which probably they themselves specially pursued, and no attempt was made to render the whole series of professorships at all complete, so as to represent all sides of science. The professors were independent centres for the diffusion of science in particular branches. Each generally pursued his own course, and gave either no lectures, or lectures only upon that particular branch of science which he himself investigated. They did not attempt indeed to make their courses at all complete, or to go over the whole ground. The real work of teaching has been done, until quite recently, almost wholly either by college tutors and lecturers, or by private tutors.

4540. The teaching by the college tutors has been mainly mathematical, or, at any rate, confined to a few branches of science?—Yes, almost entirely, until within a very recent time. Now an attempt is being made to render the staff of professors more complete, and to require of them duties rather different from those which have hitherto been expected of them, to require them to reside constantly in the university, and to give more extended and more complete courses of lectures, so as to be really more of teachers than they have hitherto been, that is to say, teachers of the large body of the university, as distinct from a few selected students who might be inclined to pursue the same particular branch that the professor himself followed.

4541. Are you of opinion that advantages result from the carrying on of the study of science side by side with other studies?—Yes, I think that is extremely important. I know that, so far as my own experience is concerned, I learnt quite as much from contact with other students, who were perhaps pursuing a different line from my own, as I did from direct teaching, and I believe it must always be so. All special schools have a tendency to acquire a somewhat one-sided character, and to become much less philosophical than if the study of different branches of learning is carried on side by side. The contact of minds which are occupied in different lines of study is always an immense advantage.



4542. Do you think it advisable or not that a student should confine himself to one branch of study?—I think not entirely. I think it desirable that he should take up one branch and make it his more especial study, but in order to do that completely he must know something of cognate branches.

4543. Are there any special difficulties in the way of advancing the study of science at Cambridge?—I think I can name several. One that I have found myself is the extreme shortness of the time during which the mass of students are at Cambridge. For instance, the Michaelmas term nominally begins on the 1st of October and ends on the 16th of December, but the actual time during which men are in residence is very little more than two thirds of that time. I find that practically I can never get my class properly together until nearly three weeks of October have expired; it is generally about the 20th before I can get the whole of my class together. Then they are distracted with the examinations at the end of the term, so that by the end of the first week in December I have about seen the last of them. That reduces the term practically to about seven weeks, and that time is too short where very much work has to be got through. The tendency is to compress so much into a short space that it becomes a very great tax upon the teachers, and an equal tax, indeed, upon the learners. The same would apply to other terms: the Lent term begins nominally on the 13th of January, but it is almost impossible to get the class together until the beginning of February. Then as to the Easter term, soon after Easter I generally get the class together, but they break up at the end of May or thereabouts, so that the Easter term is generally reduced to about five weeks. So that in the whole year there are only about 19 weeks of real work.

4544. Are you prepared to say to what extent you would wish to increase the number of weeks given to work?—I should like to see the work begun at the beginning of the term and carried on to the end. I do not think that would be any too much. I should not wish for the work to be carried on quite so hard during that time as it is now, that is to say, quite so hard as it is by the hardest working students; but I think more could be done if it were spread over a little longer time, it would be more thoroughly digested, and would be done with very much less labour.

4545. Would you wish to see the long vacation materially diminished?—No; I should not wish the long vacation diminished. If they would work on to the end of the term, that would be near the end of June, and there would be then three months' vacation.

4546. Do you think three months sufficient for the long vacation?—I think so. I think that the advantages derived from the long vacation are very great, by the opportunity which it gives to teachers especially of pursuing their own line of study, whatever it may be.

4547. And a great number of the better class of students study a great deal during the long vacation, do they not?—Yes, and their study, of course, is not confined to the actual time during which the lectures are being given. That class of students go on learning during the greater part of the year, but still the shortness of the term is an impediment, because it is impossible to get the whole class together, even if some are ready to begin earlier than is now usual.

4548. There are also difficulties arising from the insufficiency of the professorial staff, are there not?—Yes, considerable difficulties. I do not think that can be better illustrated than by my own case. I have the whole of the teaching of chemistry so far as the university is concerned, and indeed up to this time of everything else in any way connected with it. When I first began there was no other teaching at all in any of those subjects either in the university or in colleges. My predecessor in the office, although a very distinguished man, was an old man and unable to do much, and I acted for some years as his deputy. There really was nobody

else to take part in the teaching at all. Matters have become a little better now, because there are several college lecturers on such subjects, but there is no sort of organisation. Each lecturer is independent, and I have no authority or control over the others in their courses of lectures, and I am obliged to meet the wants of students as well as I can. I have not only to give lectures on the general principles of the subject, but also to give all the practical instruction which is given, and that really is more than one man can properly do. I find that as long as I am able to go on the interest keeps up, but as soon as I slacken the interest flags. A larger staff would be able to give a very great impulse to the study of chemistry and other allied subjects, and the same applies, to a certain extent, to other subjects.

4549. Should you like to see the number of professors materially increased, or would you rather look to the establishment of a class of sub-professors, and to regard the college tutors in some degree as assistants to the professors?—I think the latter plan would answer very well, provided there were a proper system of organisation, so that each might take his own special department. By the present college system, the college tutor teaches the men mainly of his own college, and there is no connexion with the university teaching at all. In some cases the colleges amalgamate, two or more colleges may have teaching in common, but still they are independent of the university professors and of the system of university teaching.

4550. The colleges have amalgamated, have they not, to a certain degree, so far as the natural sciences are concerned?—Yes, and to some extent with regard to other subjects. Classical lectures are given, I think, in five or six colleges in common; in two batches of colleges, indeed, they are given in common.

4551. Should you like to see an addition made to the staff of professors, so far as chemistry is concerned?—Yes; I think it is very important.

4552. Would you divide chemistry into several branches, or would you have more than one professor teaching the same department of chemistry?—I do not think it is necessary to have more than one professor teaching the same department of chemistry; I think there would be good occupation for three, and it might be divided into three departments. One professor might take the general principles of chemistry and give lectures to a large class; perhaps, another might take the catechetical teaching of the beginners; and a third might take analytical chemistry.

4553. For the purpose of catechetical teaching, can a professor undertake a considerable number of students?—I think that he may take perhaps ten or a dozen at a time.

4554. Are the funds for the payment of professors in your opinion insufficient?—At present they are very inadequate indeed; most of the professors' stipends amount to about 300*l.* a year; there are some, of course, that are better paid; but besides that they have in some cases no provision whatever made for apparatus and other requisites in their laboratories, or next to none.

4555. Are you badly provided with laboratories and museums?—No; I have a very fair laboratory, but I am not provided with any apparatus for my chemical lectures. The students' laboratory is provided with apparatus, but I have to find what I want for my own use. All my chemical apparatus and almost all the other things connected with my professorship are my own property.

4556. Are the stipends of the professors at all supplemented by fees?—To some extent, but the outgoings, in the case of a professorship like mine, are very large, so that they pretty well swallow up all the sums which I receive from fees.

4557. I believe that either nothing, or very little, has been done at Cambridge in the way of attaching college fellowships to the professorships?—I do not know that there is any case in which a fellowship is actually attached to a professorship. There are some cases in which professors have been elected

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80 Nov. 1870.



G. D. Living,  
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30 Nov. 1870.

fellows, and they retain their fellowships as long as they retain their professorships, but it does not at all follow that their successors in the professorships will obtain the same fellowships, or any others.

4558. Do you think that that would be an advisable method of adding to the income attached to the professorships?—Yes, it seems to be a reasonable application of the fellowships.

4559. Is there any tendency in Cambridge to adopt that system?—It has been adopted in some cases. Professor Challis was recently elected to a fellowship at Trinity, and Professors Stokes and Fawcett, not very long ago, were elected to fellowships; and there are other cases in which fellowships are held by professors.

4560. Do you find that the professor's time is much distracted by the necessity of making a livelihood in other ways?—I find it so in my own case. A considerable portion of my time is almost necessarily employed in occupations which are distinct from my proper work as a professor.

4561. Do you not find that too heavy a strain upon you?—Yes, I do.

4562. Can you give the Commission any advice as to the means which you think would be best resorted to for obtaining the requisite funds?—In the case of Cambridge, I know of no other means than the application of some of the college endowments to such purposes.

4563. The university funds are pretty nearly exhausted, are they not?—I should think that they are quite exhausted.

4564. What you have sketched out as to the necessity for additional professorships, and for adding to the stipends of the existing professors, would require a considerable contribution from the colleges?—It would require a considerable contribution, but not, perhaps, a very large one compared with the whole revenues of the colleges.

4565. Besides your own department, are you of opinion that additional professors are required in other branches of science?—Yes, I think so.

4566. The candidates for an ordinary degree are now required to pass through a special examination, after having passed through two general examinations previously?—They are.

4567. And an examination in natural science is one of those requirements?—Yes, either natural science or certain other branches of learning may be taken at the option of the candidate.

4568. Is chemistry one of the optional subjects in the natural science examination?—Yes, it is.

4569. Are the candidates who pass in chemistry obliged to attend your lectures?—I suppose that at present they are. They are obliged to attend the lectures of some one of the professors upon subjects allied to that. I do not know whether there are any lectures but mine that would answer to that description.

4570. Do any of the ordinary pass-men attend your lectures?—Yes, not very many, but a few always.

4571. Are you able to give us any information as to whether that system is working well?—So far as those students are concerned, I think it works very well. Only those come to my lectures and pass in that branch who really have an interest in the subject. They are generally good attendants, generally work intelligently, and I have been very well satisfied with what they have done, but the number is very small.

4572. But they have not sufficient attainments, I presume, to be able to take honours in the natural science tripos?—In some cases I think they might have taken honours, if they had chosen to remain another term at the university and pay a little more attention to the subject.

4573. Have you a separate class for those who intend to take honours in the natural science tripos?—No; I sometimes give a separate course of lectures, which is intended for such students only, but I find that others generally attend.

4574. Have you any considerable number attending your lectures who propose to go out in honours in

natural science?—Yes, the larger part of my class I think attend with that view.

4575. Is the number increasing?—Yes, it is increasing decidedly.

4576. Do you think that they go out in that branch from a predilection for natural science, or is it with a view to their after career?—I think that in many cases it is from a predilection for natural science. There are a certain number of medical students in addition.

4577. I believe, besides giving lectures in chemistry proper, you also give lectures on heat?—I do.

4578. Do you think that that ought properly to be combined with your duties as professor of chemistry?—I think not. I think that chemistry is quite a sufficiently wide subject without having allied branches of science attached to it.

4579. In those lectures, is heat treated mathematically?—Only very elementary mathematics are introduced. They are chiefly experimental lectures.

4580. Does not heat form a subject of examination in two of the divisions in which an ordinary degree may be obtained?—Yes, in the division called mechanism and applied sciences, and also in natural science.

4581. And the students for both of those divisions attend your lectures?—Yes, they do.

4582. (*Mr. Samuelson.*) Have you prepared, in your own mind, any scheme of the professorships which would be required in order to make Cambridge an efficient school of science?—I really have not considered the question sufficiently to give an answer off-hand. I have not had my attention directed to that point lately, and I doubt if I could answer the question in a satisfactory manner at once. Of course I have thought about it in the case of my own department, and I have already stated what I thought was wanted there.

4583. Assuming the professorial staff to be completed, and sufficient encouragement to be offered in the way of scholarships and fellowships, what do you think would be the result to Cambridge as a school of science? Would you expect to draw your students from a different stratum of society from that which now furnishes students to Cambridge?—I should hardly expect that, so long as the same amount of residence is required as is now required for a degree. Three years' residence is the least time that is required for a degree, but I think that if our examinations were made open to all, whether they have resided or not, a great many would come, say for a short time, and would pass the examinations and get a great deal of good, and they would come perhaps from a different class of society from those who now frequent the university.

4584. With what object do you suppose those men would come up?—For the sake of education, to obtain a better preparation for whatever profession it was that they intended to fill, for getting scientific training as distinct from professional training.

4585. The difficulty at present being that there is scarcely time for both?—No, there is hardly time for both. The time at which most young men come up to Cambridge is a little too late. Few come before they are 18, and they have to spend three years, from 18 to 21, at the university. 21 is rather late to begin the proper professional study which is the preparation for a man's after life, as distinct from general education.

4586. They could scarcely come up sooner, because were they to do so, they would come up insufficiently prepared, would they not?—They would as the schools now send them up certainly; and also the competition for all sorts of rewards would be rather unfair to them. A lad coming up at 15 or 16 would be placed at a disadvantage compared with one coming up at 18. The schoolmasters all endeavour to keep their most promising pupils a little longer, if possible, in order that they may do them more credit, and because they are also the most pleasant pupils to teach. All these causes tend to keep lads away until they are 18 or thereabouts.



4587. So that, so far as Cambridge is to be made available as a school of science for professional men, it would be essential that they should be at liberty to take as much or as little of science as might be compatible with the time required for their professional training?—I think so.

4588. And until some arrangement of that sort were made, you do not think that Cambridge could be made available as a place of study for a large number of professional men?—I hardly think that it would be. I will not say that it could not be, but I hardly think that it would be, because the class of men that you are speaking of look so much to what will pay them. They may be content to spend one year at a place like Cambridge, when they would not be at all content to spend three years there, or, at least, their parents would be very ill content to spend the money that would be necessary for it. I believe that a great many would be glad to have one year at Cambridge, and that they would do so at once if it were open to them to pass the examinations and get a satisfactory testimonial as the result of their study there.

4589. And in those cases in which a certain amount of manual dexterity is required, it would actually be impossible for them to remain long at Cambridge without foregoing the other half of their professional training?—For some professions it would be so, certainly; but I do not see at all why practical schools of that sort should not be attached to the university. We have several laboratories for our chemical work, in which almost any kind of chemical work can be carried on except on a manufacturing scale; and I do not see why laboratories of other kinds should not be established there, at which men might learn actual manipulation.

4590. Is there any experience of such laboratories having been successful anywhere?—I do not know, beyond what are called physical laboratories, which are very much the same sort of thing as chemical laboratories, where the object is rather to investigate scientific truths than practical applications, whether any such laboratories have been successful in connexion with a university.

4591. At the same time, if the student's course were prolonged sufficiently, it would be possible, in your special department, to teach the application of chemistry?—I think it would, certainly.

4592. Do you think that that could be done with advantage?—Yes, I think so.

4593. But that again would involve a division of subjects, would it not, amongst the different professors?—It would, certainly. Some professor in that case must have the technical applications under his charge, and that would be sufficient for one man.

4594. And that, so far as the science of chemistry is concerned, would be a desirable arrangement, in your opinion?—I hardly intended to say that. I think that it might be very well taught at the University, and perhaps better, side by side with theory, than anywhere else. What effect that would have in diverting students from what I should consider more important to them, as far as Cambridge education is concerned, is another question. I am afraid that some who ought to be learning thoroughly the great principles of science, might be diverted to the practical applications of science, which seems to me to be quite a different thing. That is a difficulty we have with medical students: they are learning side by side a certain amount of science and a certain amount of practice, or of special professional learning of some kind or other, and it is found extremely difficult to get them to give sufficient time to the scientific side of the subjects, so as to be able to take thoroughly philosophical views of what they are about. I am afraid that the same thing might happen if there were special schools or special branches in which the applications of science, rather than science itself, were the principal object.

4595. You would expect practical men to become somewhat more scientific, but you would be afraid of

scientific men being less thoroughly instructed than they are at present?—Yes.

4596. That, I suppose, is really the distinction in the education given by a technical school and an university, which, to a certain extent, you would be anxious to preserve?—Yes, I think it is.

4597. You are one of the examiners, are you not, of what are called the middle-class local examinations?—Yes; I have examined frequently.

4598. Have you examined lately?—Not very lately—until this year, when I have undertaken some examining work. I have been in the habit of directing the examinations at one or other of the centres, but I have not, for the last three or four years, taken any part in looking over the examination papers.

4599. But you have examined some of the large schools?—Yes, I have, and I had before that time looked over the papers for the local examinations.

4600. But at that time the system was only in its infancy, I believe?—I began with the beginning. It has been now going on for 12 years, and I should think for seven or eight years I have taken a very large part in the examinations.

4601. So far as science is concerned, do you believe that that scheme has made any impression upon the country?—Very little, as far as science is concerned. The work done, has improved, but it goes but a very little way. For example, this year, out of more than 1,600 junior boys there are but 73 candidates in chemistry, and about as many in zoology, while in botany, the numbers are very much less than that. For the seniors, the proportion is scarcely larger. Out of 300 or 400, there will not be more than 20 or 25 in chemistry, and a few in zoology and botany. The whole number is small compared with the number of candidates, but the work which they do is better now, certainly, than it was at the beginning of the examinations.

4602. The heads of those schools are beginning to understand better what is required?—I think they are beginning to understand it, but they do not yet understand what parts of science boys can learn. They have not been themselves instructed as a rule in science, and they are a little at sea as to what boys can well be taught, and still more so as to getting good teachers. It is almost impossible at present to find good teachers in sufficient numbers.

4603. Assuming good teachers to be found, what branches do you consider to be best adapted for boys up to 16?—For little boys such branches of science as principally require the exercise of observation and comparison, such as the sciences of classification. Lads about 15 may with very great advantage study such subjects as chemistry, heat, and other branches of physics, so far as they are capable of being reduced to tolerably simple and distinct laws. Of course, the more complicated applications they can hardly take in, but the simple laws of those branches of science I think they may learn with great advantage. They are able to grasp laws which admit of direct illustration, and to reproduce them, and in some cases in which I have examined schools I find that satisfactory progress has been made in such subjects.

4604. Under a good system of teaching do you think that those schools could send up boys fit to compete for your open scholarships at the age of about 17?—I think they could.

4605. You stated that you are one of the examiners at Woolwich; in which branch do you examine?—Experimental science, that is chemistry, heat, and electricity.

4606. Are the candidates there furnished by a large number of schools?—I never see the complete list of the schools from which the candidates come, but I think that they come from a considerable number of schools scattered about the country; a good many from the large proprietary schools, such as Cheltenham College, and a good many from Wellington College, and some from Harrow.

4607. Are the boys from those places coming up tolerably well prepared?—I have no means of know-

G. D. Living, Esq., M.A.

30 Nov. 1870.



G. D. Living,  
Esq., M.A.  
30 Nov. 1870.

ing that, because the candidates are all examined under numbers, so that I can only speak of the batch of candidates as a whole. I cannot sever the students of one college from those of another.

4608. But can you give the results?—When I first began to examine, nothing could be worse, hardly, if any pretence to knowledge was to be made; but they have gone on improving, and the knowledge has become more exact, and to some extent more thorough, and though it does not extend very far now it is of a better kind than it was at first.

4609. What is the age generally of the candidates?—The candidates for Woolwich must be between 16 and 19, unless the regulations of the War Office have been recently altered.

4610. (*Sir John Lubbock.*) You expressed an opinion as to the power of testing information by competitive examinations. I wish to know whether in your opinion chemistry is liable to any particular difficulty as compared with other branches of knowledge in respect of its greater liability to cram?—I do not find that it is so at all.

4611. Do you think a good examiner would be able to detect cramming?—I think so.

4612. The colleges do not all assemble and break up, do they, quite at the same time at Cambridge?—No, they do not.

4613. That probably adds to the difficulty of getting consecutive work?—Yes, it does. Trinity College is often eccentric in that respect.

4614. I presume, as a practical suggestion, you would think it very desirable that they should all have one common time for assembling and breaking up?—Yes, nominally the first day of term is the beginning of work, and I should expect that all the students should appear on the first day, or on the second day.

4615. But practically they do not do so?—No.

4616. With regard to the elementary schools in the country, do you think it possible to introduce into them any teaching of science, using the word "science" in a broad sense?—I should think hardly any, except the classificatory sciences, botany and zoology. Of physical geography but little; since physical geography involves a more complicated knowledge of the laws of nature, of rather a varied character. The laws of heat and pneumatics, and so on, must be learned before much physical geography can be learned.

4617. Botany, you think, and probably a little astronomy, and explanations of the general phenomena of nature, for instance, the recurrence of day and night and summer and winter, might be introduced?—Yes, I think that might be made intelligible.

4618. (*Sir James P. Kay-Shuttleworth.*) With respect to elementary schools, might not some instruction be given in great general laws, such as are now taught concerning astronomy, as, for example, the great and unknown duration of the earth, and other things which tend to correct erroneous notions?—I think it would be found very difficult to get children, at the age at which they are attending primary schools, to grasp such matters.

4619. Not even such general laws?—No, I think you cannot get them to grasp anything beyond the sphere of their direct observation; flowers, and such like, they can observe, and, perhaps, a little of the laws of heat, and a little of the laws of mechanics they may learn, but they could not go very far.

4620. Taking geography, might they not be made to understand the drainage of their own neighbourhood?—I think, perhaps, they might understand that.

4621. And so come to some general idea of the drainage of the county, and thence of the drainage of Great Britain?—Yes, I think by such steps they might arrive at some knowledge.

4622. For example, children no longer believe commonly that the sun goes round the earth; they have come to know that the earth goes round the sun?—They are told so. I do not think that they have any

adequate comprehension of either the one or the other.

4623. But, as a fact, either upon authority or by reasoning, they have come to know also that the earth is round?—Yes, they accept that in the same way.

4624. And in that way might not certain general laws and some primary facts, by authority or by the influence of some effort of reasoning, be communicated to them, so as to correct superstition?—I think, perhaps, it might be so, but I think that knowledge of that kind as a rule does not extend very far. They may accept the fact that the earth is round, but they would never get over the notion that people at the antipodes are not standing upon their heads.

4625. Is it not important, however, that they should not regard the appearance of a great comet with superstitious horror?—I doubt whether they do so now, as a general rule.

4626. But it is desirable that they should not, presume?—Certainly it is desirable that they should not.

4627. And also a total eclipse of the sun, or any great phenomena of the aurora?—It is very desirable that they should understand, no doubt, that those things follow certain natural laws.

4628. Beyond that you are of opinion that very little could be taught of science?—I am afraid not, in primary schools.

4629. Could you, from your acquaintance with what I may call the middle-class schools, including the endowed schools and the public schools, inform the Commission whether any laboratories or museums or other practical appliances are established for instruction in science in connexion with such schools?—There is a class room fitted for this purpose at the Birmingham School and at Harrow; and there are more complete laboratories at Rugby, Clifton, and, I believe, also at Cheltenham. The last time I was at Eton, they were just starting something of the kind, and I suppose it is done. The Sheffield Collegiate Institution has I believe such appliances, and the Liverpool College, but I do not know much of the Liverpool schools.

4630. Those laboratories, I believe, are chiefly chemical?—No, not entirely; at Birmingham, Rugby, Cheltenham, and Harrow, certainly, they include other branches of physics in their course.

4631. Can you say how many hours per week the boys are allowed to devote to scientific instruction?—I cannot say that off-hand. I have no distinct remembrance of the time. I consider the time inadequate, so far as I have seen. They underrate the time in which new ideas can be grasped, and the time required really to turn them over before a fair knowledge can be acquired.

4632. Is that instruction in science given in a separate department, or is it made co-ordinate with the ordinary classical study?—In most of the schools there has been a considerable battle between the classical and the scientific departments, and, on the whole, I think they are generally kept separate now.

4633. Is that done by a system of bifurcation at a given period of instruction?—That has been recently adopted at Harrow, and at Cheltenham it has been adopted for some years.

4634. Can you inform us which plan has received the largest amount of approbation and success?—I think that the success is greatest where they do bifurcate, so far as science is concerned, but the scientific masters complain that they get only the idlest or most ill-taught boys consigned to them.

4635. Are you aware that the intention of the Endowed Schools' Commission is, if they obtain the concurrence of the trustees, to found, with the existing endowments, some purely modern schools, so called, in which Latin and not Greek shall form the basis of literary instruction?—Yes, I am aware that that has been brought under the attention of the University of Cambridge recently.

4636. Supposing that the intention of the Commissioners should be thoroughly carried out, and that



there should be in every county in England some prominent schools in which Greek was not taught, but Latin and modern languages were made the basis of literary instruction, would you think it desirable that the university should adapt itself to the reception of youths who had received instruction in such schools?—I myself think it is desirable that it should adapt itself to the reception of youths from such schools.

4637. Having regard to the career of a young man in the university, if he came up and passed any initiatory examination which satisfied the university of his having acquired a certain amount of literary culture, would you after that time allow him to pursue science without impediment?—I think I would.

4638. You would allow him to take a scholarship and a fellowship, and so enter into the government of the university by scientific culture alone, after his first examination?—I would. That is done to a certain extent in the university now.

4639. At what period does that examination occur?—It may occur, in the case of a medical student or a candidate for honours as early as his second term, but in the case of other students not earlier than their third terms.

4640. But you would be disposed to take it at his entrance into the university?—Yes, I would allow it to be optional at his entrance.

4641. Supposing that the intentions of the Endowed Schools' Commissioners were carried out in the way I have described, and that the literary culture of Latin and modern languages were considerably combined with scientific culture, you would expect that such preliminary examination would give the university every proper assurance that the student, taking scientific culture in it for honours, might be regarded as a learned man without learning Greek?—Yes, as far as the examination test goes, I should. I do not see any other test that the university could reasonably require at that period of a man's course.

4642. Did I rightly understand you to say that the courses of many of the professors, regarded as means of scientific culture, were incomplete?—They are certainly extremely incomplete, that is, there are gaps in the system, branches of science scarcely touched. The medical professors, who are obliged to give more complete courses of instruction, are to some extent an exception.

4643. Does the course taken by a professor depend upon his own will, or is it regulated by the college?—It really depends upon the professor's own will. They are supposed to be co-ordinated by means of boards which were established recently, but it is impossible to bring the whole of the professors under the operation of those boards, and, at present, they have very little influence.

4644. I think I have understood you to give a preference to the organization of the professoriate under the university, rather than its being connected separately with each college?—There is a great waste if it is connected with the separate colleges, and ground has to be gone over by several teachers which might be gone over perfectly well by one alone. An organised system would enable some of them to devote more time to the details of special branches than the college system allows.

4645. And you are not very sanguine that the colleges would make all the necessary appropriation of funds and regulations for the university professoriate

for the culture of science, unless under the influence of some external authority?—I think not. At present, no doubt, there is a growing feeling in favour of some such action, but it does not extend to all the colleges, and it is very difficult to carry out any such appropriation as long as even one college stands upon its rights; in fact, I see nothing but an Act of Parliament which would meet the case, and I think that an Act drawn with sufficient consideration of the mode of administering the funds contributed would be accepted without very much ill-feeling in the university now.

4646. Likewise, if the courses of the professors are to be rendered so complete as to afford to students seeking scientific culture adequate means of completing their education, it might be desirable that there should be some regulating authority over the whole university to determine the courses of the professors?—I think that would be necessary, as there must be some body which shall have the ultimate appeal in such cases; but I think that the professors would have no real difficulty in agreeing amongst themselves if they felt that they had a common object.

4647. I am not meaning that that authority should be external, but that there should be some means, either by a council of professors or others, of regulating the courses of the professors, so that they might conduce to a common result?—I think so, certainly.

4648. In fact, I generally gather from you that a great deal of force is wasted, and that there is a want of organisation?—It is so, certainly, taking the university and colleges together.

4649. And, that the best wishes of those who are foremost in desiring the improvement of scientific culture in the university are frustrated by that want of organisation, and want of power to bring about a common result?—Yes, to some extent. But the whole power which is at present applied to science strictly is very much below what I should like to see applied to that end. Much at Cambridge has always been done by private tutors, but there is no class of scientific private tutors, or at least the class is very limited at present.

4650. You would desire to see more professorships, that the professors should be better aided by sub-professors and by demonstrators, and that there should be a larger application of endowments for their sustentation, and likewise of rewards to the students?—Yes.

4651. All that could not be, as far as you can see, procured by any internal force of agreement now in the university?—No.

4652. As respects your own chair, would you desire, looking to instruction in analytic and synthetic chemistry, that it should be divided into branches under separate professors or sub-professors?—I think it would be desirable. The time which is required to give instruction in analytical chemistry is very large, the students require to have somebody always at hand, or, at least, pretty freely and readily accessible, to instruct them; and a great deal of time is necessarily consumed where you have a class, each one of whom must be working to some extent independently, in explaining difficulties which are not common to the whole class.

4653. You have always made what additions you need to your own apparatus for lecturing, and at present, I believe, there is no adequate means of providing it?—There are no means at my disposal, and I have always paid for the greater part from my own pocket.

The witness withdrew.

Adjourned to Tuesday next at 12 o'clock.

G. D. Living,  
Esq., M.A.

30 Nov. 1870.



No. 6, Old Palace Yard, Westminster, Tuesday, 6th December 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

THE MOST HON. THE MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

The Rev. R. WILLIS, M.A., F.R.S., examined.

Rev. R. Willis,  
M.A., F.R.S.

6 Dec. 1870.

4654. (*Chairman.*) You are the Jacksonian Professor of Natural and Experimental Philosophy in the University of Cambridge?—Yes.

4655. This chair, I believe, was founded, was it not, towards the end of the last century?—Yes, it was.

4656. What were the duties attached to the chair at its original foundation?—The duties are very ill defined in the foundation deed. They contain a number of anomalous subjects for lectures, as for example: the founder directs his professor to be well skilled in philosophy in general; but, amongst other things, he enjoins his professor to endeavour to discover a remedy for the gout. He ought to be well skilled in anatomy also, and some other subjects which I do not recollect, but every succeeding professor has modified the mode of giving the lectures.

4657. Perhaps you will be so good as to explain in what sense you have understood the duties attaching to the professorship?—When I came to the professorship, I succeeded Professor Farish. Professor Farish lived just at that era when machinery was being developed for the purpose of manufactures, and he contrived a system of apparatus by which he could build up the machines that were required from day to day for his lectures, and he did that with great ingenuity and success. That was about the beginning of this century, and when I succeeded to him I also devoted my lectures to the teaching of machinery, but as I found that his apparatus was made according to a system which was already becoming antiquated, I devised another system of building up, which I have employed ever since, and which I have found very successful; in fact it has been adopted by a variety of other lecturers in different places. The subjects that I take for my lectures are the general principles of mechanism, and I exhibit to my audience the machinery for performing various manufacturing processes, as, for example, the making of rope, the nature of weaving, the nature of planing machines, and shaping machines of all kinds. Every example that I can get or imagine I have endeavoured to present to my audiences by means of the system of apparatus that I have been working at so long. As to the knowledge of anatomy, I have shown and illustrated that by some investigations that I made some years ago on the comparative anatomy of the crustaceous animals, in which I showed that the outer shells of those animals were formed upon the principle of what is called the "Hooke's joint." There are pieces made with axes of flexure, and those axes of flexure are so combined in the manner of the "Hooke's joint," as to allow the pieces so united to be turned and twisted in all directions, as if they were connected with a spherical ball in its socket. That is necessary, because in other animals, ourselves, for example, the bone is in the centre of the muscles, and therefore you can have a good round ball to make a universal joint for your arm, but the crustacean cannot have that, because his muscles are inside the bony case. That discovery was at once accepted, and has been adopted ever since I published it. I also show large moving models of steam-engines, and I also exhibit and lecture upon the principles of architecture. The theory and practice of vaults are illustrated by models under my own direction, and for the most part finished up by my own hands, or, if they are not too large, made entirely by

my own hands. Throughout the whole of the varied subjects that I employ and illustrate in my lectures, I have always endeavoured to give those that are the most practical and the most instructive as types of different classes.

4658. Do your lectures require much knowledge of mathematics?—No; only the ordinary forms of mathematics. It is impossible to teach mathematics in an apparatus room by apparatus, but the mathematics are supplied by my own text-book. I have written a work on the principles of mechanism, of which a new edition has just been issued, and it is to that that I refer my pupils for mathematics; they read the chapters which belong to the machines and contrivances that I have exhibited to them.

4659. Does the university assist you in providing apparatus to illustrate your lectures?—No, I have had no grant of money for that purpose; the whole of the apparatus has been made out of my own private purse in fact.

4660. I believe the professorship is not very richly endowed?—It is termed the Natural and Experimental Philosophy Professorship, but it is endowed with an estate by the founder of 160*l.* per annum. To this is added such a sum paid from the university chest as will augment the endowment stipend to 300*l.* per annum, on condition that the professor resides within the precincts of the university for 18 weeks in every year between the 1st of October and the end of the following Easter term. But beside that we share the fees. The fees now are collected by means of cards which are purchased at the registrar's office, and which entitle the holder of the card to select any professor that he pleases, and he is bound to attend three-fourths of his lectures, and then he will have a certificate which will enable him to go up to examination for a degree; but the university have for some years made a rule that every student who is going to take a degree must attend the courses of lectures of one or more of the professors in order to give him practical knowledge.

4661. And your professorship is one of those included in that list?—Yes. The total sum that is received by the registrar of the university is divided equally among the lecturing professors.

4662. Are the candidates for degrees who have attended your lectures examined in the subject of the lectures? Is there a final examination for a degree?—Yes.

4663. Are your lectures attended chiefly by the candidates for the ordinary degrees or candidates for honours?—I think either one or the other, but I do not know; they never tell me whether they are candidates for honours or not, but they comprise all ranks of society. The fact is, that machinery and mechanism is a subject that has excited the attention of all ranks, from the prince to the peasant, and continues to do so. I am very seldom without two or three noblemen's sons in my class, and on the other hand I have other men who intend to go into the profession of engineering and other professions which require a knowledge of the principles of machinery; the rest of them are amateurs.

4664. Have you usually a large class attending your lectures?—Yes, I have a very large class. There is



a very good lecture room provided for me, and large apparatus rooms.

4665. Do you examine those who are attending your lectures yourself?—No.

4666. The lectures are not of a catechetical character in any respect, I presume?—No. From the nature of the lectures, as the motions are taught and shown by separate models, they require very little teaching and explanation.

4667. Do you find considerable interest taken in the subject of your lectures?—Yes; from the nature of them a man would not attend the lectures unless he liked the subject. I have held the professorship now ever since 1837.

4668. Professor Farish's lectures were very popular, were they not?—Yes; but for Mr. Farish's lectures I should not have had these things suggested to me; he first gave popularity to the professorship in fact.

4669. Can you state whether any large number of attendants on your lectures have become distinguished as engineers, or in any other line of professional work?—I can hardly follow out their course unless they have been intimate friends of my own. Some of them have gone, I know, into the engineering profession, and others into mechanical engineering.

4670. Could the university give greater advantages to you in conducting your lectures than you possess at present?—No, I think not.

4671. If a larger amount of funds were applied to the subject, could your lectures in any respect be rendered more efficient than they are at present?—No, I think not. I am now fitted up with a complete set of apparatus; and when a new contrivance arises, or I discover it in an old book, or out of my own brain, I can build it up immediately, and exhibit it to my audience. I have an assistant, what you would call, perhaps, in London a demonstrator, and he sets the things in motion.

4672. Is he provided by the university?—No, he is paid out of my own pocket. Naturally, the demonstrator must be a different man for each professor. In anatomy, for instance, he must be a medical pupil, and for machinery in my professorship he ought to be a workman, and so on.

4673. Have you formed any views that you could favour the Commission with generally with respect to the encouragement of scientific instruction in the university?—I have not thought much about that as a general system, certainly not. I have occasionally given lectures in architecture, of which I am very fond, but they have been only half a dozen lectures such as you would get at the Royal Institution in London, where I have also lectured upon architecture.

4674. Do you find considerable interest taken by the young men at Cambridge in the subject of architecture?—Yes, especially in archaeology.

4675. There is no examination in that subject, is there?—No, it is not a university subject; it is only a subject that is interesting to the world at large.

4676. Do you illustrate your lectures by models?—Yes, I do by a peculiar system of modelling which I contrived for myself, in which the models of buildings, churches, or whatever they are, are made of cardboard, in such a manner that I can begin with an old church from the foundation, and go on adding an arch here, and a tower there, and a porch in another place, and then lengthen the chancel of the model. I can put them all together and take them down again. I have found that mode of teaching architecture very effectual indeed.

4677. You are hardly able to tell us whether those students who are in the habit of attending your lectures are those who are working hard upon the more regular university subjects at the same time?—No, certainly not. Only their own college tutors could tell that.

4678. (*Professor Stokes.*) Are you of opinion that as regards teaching mechanism the university had best confine itself to general principles, or that it would be desirable to found an actual technical school, a school

of civil engineering where the pupils should work in the workshop, and be taught the details?—That might be done, but I think it would distract them from their reading.

4679. You do not think that that could be well combined with a university course?—No, I do not. I think it would be better taken up after a young man had left the university.

4680. Do you think that such instruction could be carried on better in Cambridge, or after a man had been imbued with the Cambridge education, and gone out into the world?—In King's College in London, and in other places, there are workshops fitted up, and the pupils are taught to mortice and tenon, make dovetail joints and framing, but has never been adopted in the university. I think our university, which is founded for the purpose of giving men a learned education, would hardly like its pupils to be distracted at the same time with carpentry work; that should be taken up afterwards.

4681. (*Sir J. Kay-Shuttleworth.*) I understand you to say that you do not give abstract theoretic instruction in your class so much as illustrations of the combinations of machinery?—That is the drift of my evidence.

4682. I apprehend that in the courses of applied mechanics in the university, theoretic information is given on the subject of machinery?—Certainly; but besides that, I refer my pupils to the books in all cases where mathematical theories are required.

4683. Are the students who attend your class generally those who have pursued, up to a certain point, the theoretic and abstract knowledge of mechanics?—I have no means of ascertaining that. After the lecture is over, I allow them to come down on the area where my machines are placed, and from the way in which they handle the machines, and by the remarks they make, or the admiration that they express for the combinations in question, any practical man can tell by the manner in which they handle tools or machines, or chemical vessels, whether they understand the subject or not. The practised hand shows itself at once.

4684. As far as the course of instruction in the university is concerned, your lectures are not necessarily associated with any preceding course of theoretic study?—No, that is quite certain; that is not the way with the university generally speaking.

4685. Nor do they form any necessary course of study with a view to an examination under the scientific tripos?—I believe that every man who enters the university is obliged to attend the lectures of one of the professors. That does not apply to those who take honours; if they are going to take honours it is supposed that the course of reading for honours is such as to make it necessary for a man who has taken that course to give the whole of his attention to it, but if they are not going to take honours they can combine the reading of theoretical books with attendance on my practical lectures, and the sight of my mechanism.

4686. Apparently, therefore, the university in its teachings of mechanics has not considered it necessary to make it obligatory that the study of theoretic mechanics should be followed by illustrations, and such lectures as those which you give?—No, certainly; there is no chain of connexion of that kind.

4687. Have you any opinion as to whether it would be desirable that such an obligation should be imposed or not?—My opinion is that it should not be imposed.

4688. Speaking generally with respect to the theoretic and abstract instruction of the university, would you think it desirable or not that it should be followed or accompanied by phenomenical illustration?—Certainly, the mechanical powers and all those things should be exhibited to them. I think that in the colleges the kind of teaching that you would describe as the mathematical part is carried on and in many colleges they have experimental pieces of apparatus for the purpose of illustrating the laws of dynamics and of statics and so on, with what are called mechanical powers, but they do not go beyond, into what I call pure mechanism, which is merely the

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M.A., F.R.S.  
6 Dec. 1870.*



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M.A., F.R.S.  
6 Dec. 1870.

conversion of one motion into another without any consideration of the forces that are acting upon them.

4689. If you were to attempt to characterise the teaching of the university would you, with respect to science, describe it generally as abstract and theoretical, or experimental and illustrative?—Rather as abstract and theoretical. The experimental and illustrative, as I said just now, is employed in colleges in relation to those points where the theory has been applied to mechanical combinations; but there is a difference between mechanical combinations when the forces of pressure and the modifications of pressure are taken into consideration and the whole mechanism in which only the alteration of motions are illustrated, which are two perfectly different sections of the same science.

4690. I understood you, in describing the origin of the illustrative course of lectures which you give, to say, that Dr. Farish had introduced at his own expense a series of working models, and that you at your own expense had continued to provide for those illustrations of your lectures?—Yes.

4691. The university does not contribute towards that expenditure?—Certainly not.

4692. Does the university generally contribute towards the provision of apparatus for illustrative purposes?—In the case of a new professorship they might do it, but I am not sure, they may have done so.

4693. Are you aware whether Professor Liveing was not provided by the university with apparatus for the illustration of the theory of heat?—I think I have been told so. Those things are done, certainly.

4694. Generally speaking, however, the university has not contributed any large sum towards the provision of apparatus, nor, as yet, of laboratories, for either experimental research or experimental illustration?—Buildings containing laboratories have been provided by the university. The only thing that the university does in that way is to build lecture rooms for us, that is to say, each lecture room, being

assigned to a certain professor, has workshops or laboratories or whatever the rooms may be called, in which the professor arranges his apparatus for exhibition at the day's lecture, and certain private work-rooms.

4695. Have you any strong opinion as to the importance of allowing the provision of such apparatus and the introduction of such illustrations in the scientific studies of the university?—Certainly the university ought to be provided with such buildings and with such apparatus as will enable them to teach every science up to the state of perfection in which it exists at that very moment.

4696. And that experimentally and by illustration?—Yes. Where a new branch of science arises, or a science unexpectedly develops itself, those aids ought to be given from the funds of the university, I think, by buildings, or alteration in the old buildings, as would enable such studies to be carried out with all the experiments necessary for the elucidation of them.

4697. I need scarcely ask whether you would not think the illustration of your own lectures, by such models as you have yourself provided, to be a worthy object of the devotion of the funds of the university?—Yes, certainly.

4698. And that if the university were to employ its funds in that direction, such a course of lectures might be more effectually illustrated?—I doubt that very much, for I always make my own illustrations. They are not finished up as if they were for sale. I mean that exhibiting them to a class I do not think it at all necessary that they should be French polished or made with brass work where a little iron wire would do as well, because in that way men are taught to make apparatus for themselves.

4699. (*Chairman.*) Are there any other matters on which you could give the Commission any further information?—Nothing occurs to me at the moment. I would only say that it has given me great pleasure to have had an opportunity of explaining my mode of proceeding.

The witness withdrew.

ALFRED NEWTON, Esq., M.A., F.R.S., examined.

A. Newton,  
Esq., M.A.,  
F.R.S.

4700. (*Chairman.*) You are Professor of Zoology and Comparative Anatomy in the University of Cambridge, are you not?—I am.

4701. I believe that this is one of the last additions to the professoriate of Cambridge?—It is; it was founded in 1866.

4702. The university has provided, has it not, museums of zoology and comparative anatomy?—Yes, there are two museums.

4703. Was a considerable sum expended in the erection of the building?—There was, but I am not able to say of my own knowledge what that sum was; it can be ascertained, of course, very easily from the university accounts.

4704. Are the two museums of which you speak in the same building, under the same roof?—They are in the same building. The building is known as the New Museums and Lecture Rooms.

4705. In what respects are they distinguished from one another?—They have separate apartments.

4706. But both have the same objects?—Yes, one being mostly devoted to the series of comparative anatomy, and the other to the zoological series; but I do not think the distinction between them is kept up very strictly.

4707. Does the university vote an annual sum in support of those museums?—It does so. If you will permit me, I can lay before the Commission a statement of the sums which it has voted. In 1866, 264*l.* odd were allowed for ordinary expenses, 101*l.* odd for specimens, and 246*l.* for cabinets; and I have other figures, the whole shewing an average expenditure for four years by the university on those museums of 381*l.* 11*s.* 4*d.* A part of that is charged to the building fund, and part is paid out of what is called the maintenance fund, there being a distinction

between the two. The museums of zoology, comparative anatomy, human anatomy, chemistry, botany, and mineralogy are all allowed in the annual expenditure, a sum of 1,500*l.* a year out of the maintenance fund which was created by a Grace of the Senate of the 31st of May 1866, and 1,000*l.* a year called the building fund by a Grace of the Senate of April the 25th, 1861, that is to say, 1,000*l.* a year for the building fund and 1,500*l.* for maintenance.

4708. (*Dr. Sharpey.*) Does any part of that 1,500*l.* a year go for service, paying attendants, and so on?—Yes, out of the maintenance fund all expenses are defrayed, except the salaries of the demonstrator of human anatomy, who is Mr. Carver, and of the superintendent of the museums, Mr. John Willis Clark; they each receive 100*l.* a year out of the university chest, but all the other expenses for attendance, servants, and so forth are defrayed out of that allowance.

4709. (*Chairman.*) Is the building fund appropriated entirely in addition to the actual buildings?—No; it appears that of late certain fittings, wall cases, cabinets, and such like, have been charged to the building fund.

4710. Then a somewhat wide interpretation is given to the term "building fund"?—Very wide as it appears to me.

4711. Besides the money granted from the university chest, has any money been raised by private subscriptions?—Yes, a considerable amount. Since the appointment of the present superintendent, which took place I think in 1866, money to the amount of upwards of 1,000*l.* has been raised by private subscription, but I may say the term "private subscription" there includes subscriptions made by certain of the colleges (all the colleges except one) for a definite



object, which was the fitting up of cabinets in the zoological museum. For instance, 200*l.* was collected by absolutely private subscription for the purchase of Mr. Woodward's collection of shells; 740*l.* was collected, partly by subscription from private persons and partly by subscription from the colleges in consequence of a circular sent round by the superintendent and myself; in addition to that some very choice specimens, such as at times have been offered to us, and the museum fund was not able to buy, have been purchased, amounting to about 65*l.*, collected in that way, so that altogether 1,005*l.* has been collected; the average of four years collection in this way, by private subscription, has been 251*l.*, whereas the average for four years of the sums allowed by the university to those museums amounts to 381*l.*

4712. It might perhaps be well for us to learn the nature of the duties of the superintendent of whom you spoke; has he the charge of all the museums?—The superintendent has charge, not of all the museums, but only the museums of zoology and comparative anatomy; he has nothing whatever to do with the museum of geology, or botany, or chemistry, or mineralogy, and so forth.

4713. Is he a university officer?—Yes, he is Mr. Clark, formerly a fellow of Trinity College. He receives, as I said before, 100*l.* a year from the university chest, and out of that 100*l.* a year he pays 1*l.* a week, or guinea, I would not be sure which, to a person for making wet preparations; and furthermore he formerly paid entirely, and now pays one-half, the wages of another assistant. So that I may say that he expends the whole of his 100*l.* a year in wages for the university, and he gives his services gratis. He has put into my hand a statement, (in fact I gathered some of these particulars from him), which he has signed, and with your permission I will lay it before the Commission.

4714. Will you be so good as to read it to the Commission?—Mr. Clark's statement is as follows:—

"What we want at present is money; at least double what we have now, 1,500*l.* a year. This is called the 'Maintenance Fund,' and is supposed to be sufficient to pay all the salaries, and defray the general expenses of the museum, but it is not sufficient, and rather than face the question of taxation of college property for university purposes, the authorities are in the habit of charging various sums upon other funds whenever they can get the senate to sanction the subterfuge. For instance, in the course of the years 1866 to 1869, 313*l.* 4*s.* 3*d.* for cabinets in the museums of zoology and comparative anatomy *alone* has been charged to the 'Building Fund,' (a fund created by grace of the senate in 1861, for the purpose of increasing the museum buildings, and consisting of 1,000*l.* a year paid out of the chest). Again, the salaries of the superintendent, and of the demonstrator of human anatomy, are paid out of the university chest. They each receive 100*l.* a year, *less income tax*; a wholly inadequate salary, the smallness of which is made keenly felt by the arbitrary deduction of the tax. The duties of the superintendent are described in the 'Ordinationes,' but the three hours daily attendance during term are not enough for the adequate performance of his duties. The present superintendent finds it necessary to devote the vacations as far as possible to work in the museum, and even then much is left undone that ought to be done. On him devolves the care of the various collections at present deposited in the zoological museum; mammals and birds in skin, reptiles and fish in spirit, insects, the preparation and selection of the specimens for the physiological series, the same for the invertebrate series, and the same for the osteological series. To assist him in these multifarious duties he is allowed an assistant (paid 70*l.* a year out of the 'maintenance fund'), who is expected to articulate skeletons, make wet preparations, and at the same time light the fires and sweep the floors. There is a private room for the professor of anatomy

"next the lecture room, and beyond that a room for the superintendent, and another for the assistant. In these, all the work of preparation of specimens, dissection, reception of students and visitors has to be performed; and even this is in no sense of the word secured to the superintendent, for he might be ejected from it at any moment by a decision of the syndicate. I conceive that to do the work of the museums in a really efficient manner, it is necessary to allow the superintendent at once a second assistant, and a servant to clean and take care of the macerating room; to increase his own salary so much as to enable a man without private means to take the office; to build a proper dissecting room, rooms for students to work in, store rooms and the like; and to place such funds at the disposal of the syndicate as would enable them to get special assistance from without when required.

(Signed) "J. W. CLARK."

"December 1870."

4715. Do you agree generally with the views expressed by Mr. Clark?—Generally I agree with his views.

4716. Do you think that the funds which the university at present provides for the promotion of science are not adequate?—No; they are lamentably deficient.

4717. At the same time are you of opinion that the university recognises the importance of those sciences?—I think that members of it do most fully; and that they do so I think the fact of those large private subscriptions having been raised shows.

4718. Although the sum is inadequate, do you believe that it is as much as the university as a university is able to devote to the purpose?—I believe fully so.

4719. Are you prepared to give us your opinion as to any means that might be used for adding to those funds?—I think it must come in some way or other from the colleges, but I do not exactly see in what way.

4720. You are not prepared to give us a scheme which you can recommend for adoption?—No.

4721. Do you look hopefully to the prospect of steps being taken by the colleges?—I think so, with a little assistance from without.

4722. Do you mean in the shape of subscriptions?—No, I mean more in the way of pressure of public opinion.

4723. Rather in the way of the pressure of public opinion than of actual legislation?—Perhaps so.

4724. But should you like to see any legislation on the subject?—After the last specimen of it perhaps I should say not.

4725. Do you refer to the last Act?—I refer to the University Reform Act.

4726. You do not approve of the provisions of that Act?—I do not say that I do not approve of it, but it does not encourage me to wish for further legislation.

4727. A good many different schemes have been talked about, have there not, in the university for the promotion of science?—A very great many, and the one that seems to be the most widely spoken of is in direct words the abolition of the heads of houses, which no doubt would throw a very considerable sum of money at the disposal of the university; but I am certainly not prepared to say that I recommend any such scheme. I think it is possible that the heads of houses might find some duties to perform which they might perform with great advantage to the university.

4728. Do you think that they might be combined with professorial chairs?—That I can hardly say; it is possible that they might.

4729. Are the duties of the heads of the smaller colleges very onerous?—I suppose that the heads of the smaller colleges do quite as much work as the heads of the larger ones. I should think in proportion to the number of men certainly, and perhaps even actually.

4730. You have referred to one suggestion, are there any other suggestions which you would be pre-

A. Newton,  
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6 Dec. 1870.



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6 Dec. 1870.

pared to intimate, or give your opinion upon?—There is a suggestion which has been often made, and that is attaching different professorial chairs to different colleges, to be supported by the revenues of those colleges.

4731. Something of that kind has been done at Oxford, has it not?—I believe it has.

4732. There at least fellowships have been attached to professorial chairs?—Yes.

4733. I rather think a beginning in that direction has also been made at Cambridge, for Professor Challis holds a fellowship, I believe, at present?—Yes, certain professors have been at times elected to fellowships.

4734. But the fellowships are not permanently attached in those cases to professorships?—No, not permanently attached.

4735. Do you consider that the appointment of a curator has become of importance?—I look upon it as being absolutely necessary.

4736. Are the duties which would naturally fall to a curator discharged at present by the superintendent?—Partly by the superintendent, and partly by myself.

4737. You have not told us what endowment the chair itself possesses?—My own chair has 300*l.* a year.

4738. That, I need hardly say, is not a very large endowment for a professorship?—It is as large as many of the others, and larger than some.

4739. Do you think that it is desirable that the stipends of the professors should be increased, if the university had the means?—Speaking for myself, I should say so, certainly.

4740. The museum is open to others besides the members of the university, is it not?—Yes, the museum is open from 10 o'clock till dark to anyone.

4741. Is it visited by a considerable number of persons?—Yes, it is.

4742. On the whole, however, considering how recently the museum has been built, and the professorship established, do you think that as much progress has been made as could have been reasonably expected?—Yes, it has been most gratifying.

4743. Had the building of the museum and the establishment of the professorship opposition to meet with originally?—The building of the museum had a great deal of opposition to meet with; the establishment of the professorship was hardly opposed at all.

4744. On what grounds was the building of the museum objected to?—I cannot speak positively to that matter, for I was not then resident in the university. At that time I held a travelling fellowship, and was a great deal abroad.

4745. Are you able to give us any notion whether it was opposed on the ground of its not being desirable for the university to encourage the study of those sciences?—I imagine that that was the case. But now that the principle has been admitted I am sure that nearly everybody is most willing that the study should be liberally encouraged.

4746. Are you required to give a certain number of lectures in the course of the year?—I am required to give lectures, but I think that the exact number was not mentioned in the grace of the Senate, but only a course or courses of lectures. I lecture during two terms a year.

4747. Are your lectures attended by candidates for the ordinary degree?—Very few, to my knowledge, but I may say that I have no record of the candidates who come before me, except those who actually require a certificate. They leave their cards with me as indications of their attendance.

4748. Is this certificate required from candidates for the ordinary degree?—From the candidates for the ordinary degree who choose zoology as a special subject, but hitherto I think there have been only two or three such persons. Then there are a considerable number of medical students who have to attend my lectures.

4749. Are candidates for the natural sciences tripos required to attend your lectures?—No, there is no

requirement at all, but I am glad to say that I think that the majority of them do attend my lectures, although their attendance is not at all required.

4750. Is the number of young men attending your lectures increasing?—Yes, it is increasing very satisfactorily, I think. During the course that I concluded last week I had a larger number than I ever had before.

4751. A good many of those were with a view to the medical degree, I presume?—Certainly, the greater part of them.

4752. But a certain number attend with a view to taking honours in the natural sciences tripos?—Yes.

4753. Do you think that the duties attached to your professorship are larger than one man can properly undertake?—I cannot say that the duties are, but the range of subjects on which I am expected to lecture is very great, and I think that they are more than one man can conveniently manage, and I cannot help considering that it would be a very great advantage to the university if those subjects could be divided.

4754. You think that it would be desirable, do you not, that there should be a professor of zoology and another professor of comparative anatomy?—I think that would be a very good division, it being always remembered that the professor of zoology must base his zoological principles on those of anatomy.

4755. Is there any connexion between your courses of lectures and those of Professor Humphry?—We are supposed to arrange our courses mutually, and we did so originally, but I do not think that we have ever had any communication upon the subject since the first year that we began to lecture. I believe that we then agreed upon the line that we should each take, and we have each of us preserved it since.

4756. Are any scholarships or fellowships awarded for proficiency in the studies of which you are professor?—A good many scholarships, and I believe two fellowships have been given away, in which my subjects, among others, have entered into the examination, but nothing specially has been given to my subjects.

4757. Should you wish to see a larger proportion of the honours and the emoluments of the colleges awarded to students of the natural sciences?—Yes, certainly; I think it would be of very great advantage to the university.

4758. Do you mean solely for proficiency in those sciences, without any requirement of classical or mathematical knowledge?—I will not say solely, for I think that a certain amount of classical and mathematical knowledge is necessary to every man of science.

4759. You would not wish to see the natural sciences cultivated to the exclusion of literary and mathematical culture?—Certainly not.

4760. The paper which you have furnished to the Commission has intimated to us, I think, some doubts whether you think that science itself would derive any great benefit from a larger proportion of the university honours being thrown open to the students of natural science?—That is merely because when one looks around and sees the effects which the honours and emoluments of the colleges seem to have had upon some other branches of study; I am not sure that they are more advanced in Cambridge than they are at places where they are less well endowed, and I think that science is chiefly advanced by those who are working at it purely for its own sake, and not with a view of making it pay.

4761. (*Dr. Sharpey.*) Do you give a distinct course of zoology and a distinct course of comparative anatomy?—No, I do not.

4762. They form, do they, a part of the same series of lectures?—Yes.

4763. How many lectures do you give on the two subjects?—I give about 30 in the course of the year, including the two subjects.

4764. Do the students engage much in practical work in comparative anatomy?—They do so far as they are able. Many of them carry it on in their



own rooms at considerable disadvantage; and for that reason it is that we so earnestly desire a dissecting room for comparative anatomy.

4765. A dissecting room for comparative anatomy as distinct from Dr. Humphry's for human anatomy?—Yes.

4766. And in such a room, probably, preparations for the museum might be made?—Yes, but I should not recommend that practice.

4767. You mentioned, did you not, that the principal proportion of your students are intended for the medical profession?—Yes, that is so.

4768. Do you see any other inducements that students might have, besides a medical career, to take up natural science?—I think some do it purely as a matter of taste and from love of the subject.

4769. Men of independent fortune probably?—Many men of independent fortune are certainly very much attached to it. I have the means of knowing for myself by social intercourse with my pupils that such is the case.

4770. And do those men, do you think, take to original research?—I hope they may do so, but I have not been in the position long enough for such research to bear much fruit.

4771. Do you think it likely that in the case of a greater development of the teaching of natural science in the endowed schools you would have any considerable number of students who would desire to become teachers, and to accomplish themselves in natural science with that object?—I have no doubt that they would do so; simply a desire to obtain lucrative appointments would make them do so.

4772. How would you divide the duties of the professorship; I do not mean of course minutely but generally. I think you mentioned that you would desire to have one professor of comparative anatomy, and another of zoology?—I think that the professor of zoology might continue very much such lectures as I myself am in the habit of giving; but I feel that the professor of comparative anatomy might go very much more deeply into the subject.

4773. (*Marquis of Lansdowne.*) I think you stated just now that some few of the students who attended your lectures did so with a view of obtaining the certificate necessary for passing the degree examination. Are you aware of the examination they subsequently pass; do the papers come in any way under your view?—No.

4774. You have no opportunity of knowing whether the examination is such as you would consider a fairly crucial one?—It is a mere accident if I see the papers or not; but I may say that hitherto there have been only two or three such students. The experiment was only begun about two years ago.

4775. You spoke just now, I think, also of private subscriptions which had been received in aid of certain purposes, the purchase of specimens, and so forth, from different colleges. Were they given out of the college funds or merely by members of the colleges?—Some of them subscribe as colleges, and some of them very liberally.

4776. Have they funds available for such purposes which they are free to dispose of in such a manner?—They must have, for they are in the habit of giving subscriptions in aid of schools, and various other purposes.

4777. With regard to an observation, which I see in your letter, that in the event of a second professorship being founded you are by no means so certain that a corresponding benefit would be thereby derived by science itself, may I ask you whether you do not think that the more the labours of the professor are lightened the greater the opportunities he has for developing the science itself with which he is connected?—Yes, certainly.

4778. Would not, therefore, the multiplication of professorships afford the professors time for making their university a sort of headquarters of research?—Yes; in that view of the case I quite agree, but it had not struck me in that way before.

4779. Do you consider that the footing upon which science now stands at Cambridge is such as to afford any attraction to scientific men to reside at the university, and possibly to take in hand the studies of the place while engaged upon research?—I think that may be the case.

4780. Within your experience has it been the case that eminent men have frequently come from other quarters in that way?—Several eminent foreigners, for instance, have been to see the museum of zoology.

4781. But not to reside in the university?—No, I am not aware of any having come to reside.

4782. (*Professor Stokes.*) Do you think there is any reluctance felt at present to elect to fellowships for distinction in natural science provided high merit is sufficiently proved?—I think in some colleges they would not elect on any consideration.

4783. Even although the person who had so distinguished himself possessed a fair knowledge of classics and mathematics?—I think some colleges would certainly refuse to do anything of the sort.

4784. At present fellowships are not connected especially with classics or mathematics; would you think it desirable to treat natural science in a different way, by connecting the fellowships specially with natural science, or would you leave it to win its way as classics has done?—I should sooner leave it to be treated as classics were treated after the establishment of the classical tripos.

4785. Do you think that it is beginning to win its way?—I hope that it is so, but I think that in the minds of many persons no sooner does a boy begin to learn either Greek or Latin, or to know anything about a book of Euclid, than they regard him as a possible fellow, and look upon him as having a vested interest in all the revenues of the college.

4786. (*Sir J. P. Kay-Shuttleworth.*) The students who attend the professor of natural science in the university, of course come from various colleges?—Certainly they come from various colleges.

4787. As the students are attached to different colleges, it would be your opinion, I apprehend, that some funds should be derived from the several colleges towards the support of the professoriate, the advantage of which the students enjoy?—I think that the colleges might come to some agreement of that sort.

4788. If they do not come to some agreement for the support of the professoriate, from one of your previous answers I infer that you think some external pressure might be brought to bear upon them?—I am afraid they will not come to any agreement without some external pressure being brought to bear upon them, but I should like to see them do it of themselves.

4789. Supposing that the emoluments of a certain number of fellowships were reduced, or the time during which they are held was diminished, might not funds be derived from that source towards the support of a scientific professoriate?—I do not myself think that the dividends of any of the fellowships are wastefully large at the present moment, and I do not think that the time during which those fellowships can be held could be advisedly shortened.

4790. How then could any external pressure produce funds from the colleges towards the support of the professoriate?—By diminishing the number of college offices.

4791. (*Professor Stokes.*) Do you consider that college officers are highly paid at present?—I think that they are very well paid, but I may say that I have never been a college officer, and therefore I cannot say this of my own knowledge.

4792. (*Sir J. P. Kay-Shuttleworth.*) You stated that the number of students who attend upon your course were on the increase?—Certainly they are.

4793. I understand the course not to be obligatory as respects the natural science tripos, is it obligatory as respects the medical course?—Yes, it is.

4794. What rooms are there, for the prosecution of dissection or the manipulation of specimens, for the students of your class?—They have free access to

*A. Newton,  
Esq., M.A.,  
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6 Dec. 1870.



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6 Dec. 1870.

everything in the museum, and as a matter of practice they come into the superintendent's room, and the assistant's workroom, and they do there pretty well as they wish.

4795. Is there sufficient room for them?—No. It is inconvenient that they should do so, but one does not like to keep them out.

4796. But are there no separate rooms for their studies?—No.

4797. Did I rightly understand you to say that if they desire to pursue studies of that kind, they have for the most part to take such specimens home to their own rooms?—They would not be allowed to take the museum specimens, but they provide themselves with subjects for their own examination, many of them in their own rooms; and I have heard them complain of the great inconvenience to them that they were compelled to do so.

4798. As respects the museum specimens, there is no place to study them but the museum superintendent's room?—No place but his workroom.

4799. You have scarcely therefore, I suppose, been able to give as much attention to that form of study as you would desire for the success of your lectures?—Certainly not.

4800. It would be indispensable for the extension and success of your lectures, that there should be separate rooms provided for that kind of study?—Most essential.

4801. Are there not some forms of specimens likewise which you would desire that the students should themselves manipulate, and perhaps even prepare?—Certainly one would be very desirous of their doing so.

4802. But there are not now sufficient opportunities for that kind of study?—There are not sufficient opportunities.

4803. As respects the incentives to study, if your lectures be not obligatory as a part of the natural science course, is not that to a large extent an explanation of the very small number of students who apply themselves to it?—I do not think that one can say that there is such a very small number of students, considering the number of attractions that they have in other quarters.

4804. What may the number be who are not pursuing the medical course?—I cannot form a precise estimate.

4805. That class of students does not come up for examination, necessarily?—They do not.

4806. And as respects the discipline of their studies, such of them as do not come up for examination do not come very much within the range of your regulations?—No, unless they consult me on what the character of their work should be, and very many of them do so.

4807. Supposing the chairs of comparative anatomy and zoology to be divided, and sufficient rooms likewise for manipulation to be furnished, would not further demonstrators to assist those two chairs be requisite?—Certainly one demonstrator is immediately wanted, a demonstrator of comparative anatomy. I may say, that that want is met to a certain extent by the liberality of our superintendent, Mr. Clark, who

pays a person out of his own pocket to do work which really amounts to practical demonstration, although it is only preparing specimens for the museum.

4808. You said that, practically also, the superintendent and yourself are the curators of the museum?—Yes.

4809. As the museum increases in size, and as its specimens accumulate, will not the appointment of a separate curator likewise be desirable?—It is absolutely required at the present moment, merely for the preservation of the property belonging to the university.

4810. Looking to the position which you would wish the studies of comparative anatomy and zoology to take in the university, whether for the special preparation of the medical students or as a part of the study of science, you would be of opinion that a considerable appropriation of funds would be required to put it in its proper position?—Very considerable; at least double the sum that it receives now.

4811. Hitherto cabinets have been provided from a fund not originally intended to be applied to that purpose, but rather for building?—They have been provided from the building fund, and it has been interpreted that the building fund may be so used to supply cabinets.

4812. The building fund must be by so much crippled; and looking to the extension of the museum, that is in your opinion undesirable?—Decidedly.

4813. (*Chairman.*) Is there any college instruction in the sciences with which you are connected?—The nearest approach to it is that given by the newly-appointed prælector of Trinity, Dr. Michael Foster, on physiology, which of course is a cognate science; and I believe that at Caius College there is also a lecturer, but of that I am not quite certain.

4814. You have not entered into any arrangement, I presume, as to the dividing of subjects with the prælector of Trinity?—The prælector of Trinity has his own subjects distinctly marked out. He is the prælector in physiology; but although the two subjects are more or less allied, his is perfectly distinct from mine.

4815. We have heard that one obstacle to contribution from the colleges to university purposes arises from the inequality of the value of the fellowships in the opinion of some of the witnesses before this Commission; for instance, that a certain per-centage of the college revenues would fall much more heavily upon some colleges than upon others; do you think that there is any weight in that objection?—I have no acquaintance with the revenues of any of the colleges to be able to say.

4816. Have you not heard that that has been assigned as a reason?—Yes, I have heard it assigned, but I can offer no opinion of my own upon the subject.

4817. I think you have stated that in your opinion the best means by which the colleges could contribute to university purposes would be by diminishing the number of college officers?—That is one way.

4818. Is there any other point upon which you could furnish the Commission with any further information?—I think not.

The witness withdrew.

Adjourned to to-morrow, at half-past 11 o'clock.



No. 6, Old Palace Yard, Westminster, Wednesday, 7th December 1870.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

THE MOST HON. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

The Very Rev. ROBERT SCOTT, D.D., examined.

4819. (*Chairman.*) I believe that until recently you were Master of Balliol College, in the University of Oxford?—I was so until the middle of last summer.

4820. Perhaps you will be so good as to state to the Commissioners the measures that were adopted during your connexion with the college in order to encourage the study of science?—The steps that were taken at that time are detailed in a note which I had the honour of sending to the secretary of the Commission. One was the foundation of a laboratory at a time when there was no convenient laboratory connected with the University professorship of chemistry. The present professor worked there, and gave lectures in an adjoining lecture-room for some time, until the University laboratory was ready for him; but since that time it has been found so much more convenient for students to work in the University laboratory that the thing has dropped. We have also scholarships in natural science, tried for in alternate years, and tenable for three years, at 70*l.* a year. In addition to that, we had in the mathematical department the advantage of the work of Professor Henry Smith, who also then took charge of the laboratory.

4821. Had those scholarships previously been given for classical attainments?—They were a new foundation, due to the liberality of a lady who is still alive; there were three of them, to be given in alternate years for natural science, and for history and law.

4822. Have good candidates, not yet members of the University, offered themselves for those scholarships since they have been granted to natural science?—Fairly good. I should think quite as good as we had reason to expect the schools to send to us, considering the novelty of the inducement to bring men of that kind to Oxford. There was one instance, in which a man who was very satisfactory in his scientific examination, found a difficulty in satisfying the ordinary requirements in the university with respect to classical knowledge.

4823. Then of course he could not take a degree?—It was thought better that he should migrate to Cambridge under those circumstances.

4824. There is also a mathematical scholarship in your college; is that distinct from those which you have been speaking of?—Yes, it is; it has been instituted by an arrangement of the college itself, and has only been in existence for two or three years.

4825. Has the college the power of founding or of allotting existing scholarships for attainments in science, if it thinks fit to do so?—Not by its own unaided action, I think. The scholarships which are chiefly spoken of as Balliol scholarships in the University are distinctively classical, although there is a certain amount of mathematical work offered to candidates, and a certain amount of historical work. Their character is distinctly classical; and I am inclined to think that there would be a difficulty, without the intervention of the Visitor, in making it otherwise.

4826. Besides the scholarships, the college, I believe, has exhibitions in which mathematics at any rate forms an element of examination?—Yes, there are minor exhibitions of that kind which have been created in the college lately: and for these, candidates

have been invited to offer work in natural science among other branches of study.

4827. Are some of those exhibitions granted exclusively for attainments in science, or is there a certain amount of classical knowledge also required?—The examination which is specified comprises classical, mathematical, historical, and scientific subjects: but the foundation has been so recent that I can scarcely say whether it would be interpreted that a man could get an exhibition by science exclusively.

4828. The college has not at present, I believe, given any of its fellowships for attainments in natural science?—It has not. There was an occasion a year or two ago in which a fellowship was to be filled up under limitations (it was a clerical fellowship); and on that occasion, with a view to making it a little more open, candidates were invited to say what special subjects they brought up. One or two candidates brought up mathematics, and one brought up Hebrew. It might have proved difficult to say how far the scientific man could be balanced against the Hebraist; but I think that the results, on the reports of the examiners whom we called in to help us, were that there was no question as to the relative eminence of the men; and the Hebraist was elected.

4829. But the college would be willing to give a fellowship to any man for distinguished attainments in science?—I think there would be a general willingness in the college to do so. But it would be grievously hampered by our comparatively small number of fellowships, and the consequent difficulty which is felt of securing a tutorial staff in full completeness.

4830. Are the greater part of the fellows of the college employed in work in the college?—They are.

4831. You have but few non-resident fellows?—Our fellows are 11; and two have been non-resident, one of these being so only from illness, and hoping to reside, if his health will admit of it.

4832. That description would not apply to most colleges of the University. I imagine that in few colleges so large a proportion of the fellows are employed in the work of the college?—I think it is so. We have felt that we were very lucky in being able to secure the residence of so many.

4833. Has your college made any arrangement with any other colleges with regard to mutual tutorial instruction?—Yes, in two ways. In the first place, with reference to the mathematical studies, Professor Smith belongs to a group of mathematicians who in that way work together; and in the second place, the college as a body has made an arrangement with New College for a sort of joint system by which the lectures are given, some in one college and some in another, for the common benefit of both; and besides, there have been many cases in which our historical lecturer, Mr. Newman, has received by an arrangement members of other colleges into his lecture.

4834. Do you think that that new arrangement is likely to be carried further?—I should think so, certainly. It is an idea, I think, that will spread.

4835. Do you think that you will have as one result an increased attention to the study of physical science?—Very possibly we may. It is quite clear that individual colleges are not likely to have either the

Very Rev.  
R. Scott, D.D.

7 Dec. 1870.



Very Rev.  
R. Scott, D.D.  
7 Dec. 1870.

appliances or the men to teach all the branches of physical science; and I think there are indications of a plan by which one particular branch will be taken in one college, and another in another.

4836. I think you have also told us that at one time your college fitted up a laboratory, and it has now been dismantled as a laboratory: is it used for any other purposes of science, for instance as a physical laboratory?—No, it is not.

4837. Can you offer to the Commissioners any suggestions that have occurred to you, by which the University could further encourage the pursuit of science?—I feel a difficulty in doing so, because I am sorry to say that my own acquaintance with that subject is very limited, as other studies have occupied my whole time. But I do not see how the University can directly do more than it is doing at present, as far as funds go. A very large proportion of the University funds has been systematically appropriated to that department of study for many years past. In fact nearly the whole of the savings of the University, and its available means has gone in that direction since the building of the new University museum, which was opened about 10 years ago. So much so, that now the University having another pressing need (in which physical science is interested, as well as other branches of study), namely, for examination buildings, the authorities find themselves without funds, and are obliged to propose an additional tax upon all the members of the University.\* Again, a considerable number of fellowships in different colleges have been annexed to professorships, of which one half have been mathematical and scientific professorships, the others being shared by classics, moral and mental philosophy, law, and history. To some extent, also, the colleges have given scholarships; and (but this is the most rare of all) fellowships. No doubt, more might come from the funds of some colleges: but there is a feeling, I know, that the colleges have been heavily taxed already, as well as the University.

4838. (*Professor Stokes.*) I gather from what you have stated that you would not consider a diminution of the number of fellowships beneficial to your college?—Certainly not. We have always tried to do our work as efficiently as we could: and we should be crippled in the work which is most pressing upon us in the present state of University studies, if we were to lose fellowships.

4839. Do you think that the same is the case in the University generally, or that fellowships might be spared with advantage, and diverted to other objects?—In the case of some of the other colleges, I do not think there would be the same drawback. There are, however, several colleges which I apprehend are in the same condition as ourselves.

4840. Should you be in favour rather of diminishing the number of fellowships where they appeared to be more than were required, or of restricting the tenure in some manner, in the case of non-residents?—I should prefer the restriction of tenure in the case of non-residents. Whatever the necessity might be, there would be great inconveniences in the diminution of the number.

4841. I understand you that the scholarships in your college are restricted nearly to classics; the same restriction, I presume, does not operate on the exhibitions?—There are certain exhibitions which are filled up from the same examination with the scholarships. They are in fact scholarships of the second class, junior scholarships; and to them the same remarks apply as to the scholarships; but the minor exhibitions are much more general.

4842. Are the master and fellows obliged to subject those who compete for exhibitions to the same examinations as those who compete for scholarships, or is it merely a matter of convenience?—It is entirely

at their own discretion: those exhibitions have no foundation; they were voluntarily created, and might be suppressed at the close of the tenure of the present holders, if the college chose. But the object of founding them was in fact to draw to the college a larger number of the same valuable class of men as those who gain the scholarships.

4843. Then I understand that if the master and fellows were so minded, they might grant their exhibitions for proficiency we will say in natural science?—Undoubtedly; nothing is required for that but a resolution of the college.

4844. (*Sir J. P. Kay-Shuttleworth.*) The character of the University, notwithstanding the great devotion of its funds to the foundation of the museum and professorships of science, is still distinctly literary, is it not, rather than scientific?—Undoubtedly it is. In speaking of what has been done within the last few years in reference to science, of course I should not wish it to be overlooked, that this was done in the presence of all the earlier foundations in favour of literary and theological pursuits.

4845. So that the ancient traditions and the practice of the University as to the application of its endowments, as well as the bearing of its teaching is still in the direction of classical literature?—Certainly it is.

4846. Provided that a man educated in a good endowed or public school, came up with sufficient literary attainments to pass an initiatory examination satisfactory to the governing authorities of the University, would you see any difficulty in his afterwards pursuing a purely scientific career?—My own leanings are too strongly on the side of the old system to enable me to agree with that wholly. I think that in such a case the amount of pressure for classical and literary pursuits might with advantage be lessened: but I have such a very strong feeling of the importance, I would even say the preciousness, of the study of language as an element of training, that I could not go so far as many would go in the direction that you indicate.

4847. You apprehended, I presume, that my question included there being what the University might regard as a sufficient basis of literary culture before that purely scientific course was taken?—Yes; but I should not be satisfied, I think, with that which was acquired before a man came to the University, at least at the age of those who ordinarily come.

4848. You do not think that even under improved cultivation in the endowed and public schools it would be possible that they should prepare men to pass a sufficient literary examination, at the entrance to the University, to satisfy the authorities?—It depends upon the age at which men come to the University. There is now a growing number of students who come to Oxford, and I believe to Cambridge too, say from the Scotch Universities, at a more advanced age; we have had at Balliol under-graduates from Glasgow University who were 25 when they matriculated: and in the case of such men entire freedom might be quite advantageous: and there has been a certain rise in the age at which men upon the average come to Oxford within my recollection; they are rather, upon the average, later in matriculating than they used to be; but, speaking perhaps from a one-sided point of view, I should be very loth to see all further literary culture given up.

4849. At the present moment you accept the Cambridge degree in the admission of a young man to the University, and afterwards permit him to pursue simply scientific culture?—Yes.

4850. A graduate of Cambridge may have only acquired sufficient literary culture to pass what is called the "little go," and afterwards may have devoted his whole time to mathematics?—No doubt.

4851. And so he may have procured a degree?—Yes.

4852. Do you not think that a public school might present a man with greater literary knowledge than is required for the Cambridge "little go," at an initiatory

\* I find that the proposal for building new examination schools was rejected by the congregation of the University on Tuesday, December 6 (the day before this evidence was given), on the ground that funds are wanting.



examination in the University?—I should not be prepared to accept that rare instance which you have cited as a fair thing to judge by. If I were driven (which I do not wish) to decide upon that point, I should be almost tempted to say rather, "Do not admit the man on those terms." But it must be understood that I am only speaking on the supposition of the Cambridge man's attainments being altogether at the minimum, not of a man who really had reaped the advantages of a Cambridge scientific education.

4853. You are aware that the arrangements made at the museum for scientific courses afford a very considerable and growing attraction to students of science?—I am aware of that: but it does not grow so rapidly as any person who is interested in education would wish; the attraction, great as it ought to be, does not prove so powerful as one could wish.

4854. May not that in some degree be attributed to the imperfection of the preparation of young men in the public and endowed schools as respects scientific culture?—Yes, I should think so, to a considerable extent.

4855. Do you not think that the University likewise places some impediments in the way of men resorting to it for this scientific culture, by requiring, for example, Greek as a necessary part of its examinations?—That is a question of the balance of difficulties and advantages. I think that the requirement of a certain amount of Greek is very important.

4856. If the Endowed Schools' Commissioners carry out their intention of founding probably in every county at least one prominent public school in which the literary culture shall consist of Latin and the modern languages, and from which Greek shall be excluded, would you think it right to refuse to admit young men prepared in such public schools, to the advantages of the scientific culture of the University?—I should not wish to say that: but I should like to see how the schools did their work before I formed any judgment upon the subject.

4857. The present proportion of the scientific to the literary students may likewise be somewhat affected, may it not, by the mode in which the scholarships and professorships of the University have hitherto been bestowed, that is, by their being almost exclusively rewards for literary culture?—That this is the case with respect to the scholarships, I quite think; I do not think it holds good as to the professorships: there has been great liberality towards the scientific professorships.

4858. Would you wish the scholarships to be more extended to men mainly devoting themselves to scientific culture?—I think that might be advantageous, and it would tell upon the preparing schools.

4859. Seeing that the proportion of scientific to literary students is comparatively small, and that the classes of the professors of the museum must be gathered from many colleges, is it not clear that the support of the scientific professoriate has a claim upon the funds of such colleges as can afford to contribute to the scientific course?—My own impression is that that claim certainly exists; but that it has been already acknowledged in a most munificent way with respect to the museum buildings and all the apparatus and appliances necessary there, and also with respect to the professorships, considering the University's means. A good deal more might be done in fairness, I think, in the way of scholarships.

4860. There have been fellowships appropriated to the support of the scientific professoriate at the museum, have there not?—Yes, many.

4861. You think that the tenure of the fellowships might be somewhat reduced without disadvantage to the colleges?—Yes, for non-residents.\*

\* On further consideration I see more difficulty here. The limitation of the tenure of fellowships by non-residents may be, and I think it is, desirable on other grounds. But as fellowships must be filled up when they become vacant, no additional funds would accrue from this source. To raise the money required for the fellowships of non-residents, it would be necessary to lay an annual tax upon them.

4862. If by that means certain of the colleges which have not the same need of tutorial instruction, in proportion to the number of their fellows, as that which exists at Balliol, had their funds increased, would you think it right to appropriate those funds to the museum and to scientific culture?—To scientific culture, certainly: but I think that the most satisfactory way, the way which would be most conciliatory to the bodies which would have to provide those funds, would be to make them endowments for science within the college itself, to draw distinguished young men to it. They would be certainly given more willingly.

4863. There would be naturally a considerable indisposition on the part of the colleges to appropriate their endowments to University purposes?—Yes.

4864. (*Sir J. Lubbock.*) You have stated that you attach very great importance to the study of languages in cultivating the human intellect. Do you consider that for that purpose more than two languages are necessary?—I presume that you are contrasting Latin with Greek.

4865. I wish to know whether you do not think, considering that it is impossible for everyone to learn every subject, that an elementary knowledge of language might be given by the study of two languages instead of three?—I think that there are advantages in the study of Greek which the study of Latin does not supply: and I should be unwilling, except under the pressure of necessity, to surrender Greek.

4866. Would you prefer Greek to Latin?—I cannot say that: because Latin is so much more usable a tool in common life; and with regard to modern languages, Latin is so much more important: but as to its own intrinsic value, I should say that Greek is infinitely above it.

4867. Then it is not as being a language merely, but that there is something special about Greek which renders it so desirable?—I have to think of it in two ways: I do think that for a young mind a training by language is a most valuable training. Again, looking at one language and another, I think that there are very important advantages in the study of Greek.

4868. (*Chairman.*) Has any attempt ever been made to study Greek without a previous knowledge of Latin?—I am not acquainted with any such instance: but I see no reason whatever why it should not be so. If only one language is to be learnt, it must be confessed that the practical use of Latin is more widely extensive among those who are intended for ordinary life, more particularly with reference to the mastery of modern languages.

4869. (*Sir J. Lubbock.*) I understand you to advocate the teaching of language not merely with a view to its practical utility, but with reference to its effect upon the intellect?—Yes; in that view, which brings the two things a little together, I think that there are advantages in the study of a dead language over the acquirement of a living one.

4870. As far as the study of language *per se*, and the effects which the study of language has upon the mind are concerned, why should there be any difference between the study of a dead language and that of a living one?—I am not prepared to answer that with precise exactness; but the study of a dead language is a much more scientific study than that of a living language, in the great majority of cases.

4871. We can hardly question in regard to zoology that a dead animal can be more intimately studied than a living one; but I confess I still do not quite see why the fact of a language being dead should render it more valuable as being an instrument of intellectual culture?—Living languages are very rarely indeed studied with the same amount of scientific precision that dead languages are. The acquirement of a living language is almost always much more empirical in its character, and with a direct view to

Very Rev.  
R. Scott, D.D.  
7 Dec. 1870.



Very Rev.  
R. Scott, D.D.  
7 Dec. 1870.

practical use. I think perhaps that may answer your question.

4872. (*Sir J. P. Kay-Shuttleworth.*) There is no inherent necessity of that kind, I apprehend?—No, I am speaking of the large majority of cases.

4873. The practice is unscientific, but it need not be so?—No, with the exception of this particular thing, that you have a continually fluctuating element in a living language which prevents you from securing the same precision of form and grammar: whereas you have before you in a dead language a system more or less scientific, by which it is studied: and it does not vary.

4874. The truth being that, since the revival of learning, the ablest minds of all Christendom have been applied to the scientific culture of the dead languages, and that the ablest minds have not been applied to a scientific structure of the living languages?—That is, I believe, quite correct. But there is something more: in the nature of a living language there is something that eludes the grasp. It is continually changing to a certain extent.

4875. (*Chairman.*) Do you think that the amount of Greek required for a pass degree is an important acquisition to a young man?—In many cases it is not very important: but I should say emphatically, it

The witness withdrew.

T. Thomson,  
Esq., M.D.,  
F.R.S.

THOMAS THOMSON, Esq., M.D., F.R.S., examined.

4880. (*Chairman.*) Have you ever had charge of a botanic garden?—Yes, I had charge of the Botanic Garden at Calcutta at one time.

4881. You have acted, have you not, as examiner under the Science and Art Department of the Privy Council?—I have for seven or eight years, in botany generally, that is to say, in the two classes of vegetable physiology and systematic botany.

4882. What opinion have you formed as to the results of the system?—Our means, as examiners, are very limited of giving any definite answer to that question, because we do not come in contact in any way with the pupils except from their written papers, and I have no means of tracing their after career or the amount of information which they retain. Certainly I should say that it must do good, and that it has done considerable good.

4883. So far as you can judge from the written answers to your questions, do you think that a considerable amount of sound knowledge of botany is possessed by a certain number of candidates?—Yes, I think so, certainly, by a fair proportion.

4884. Have the students for the most part been improving during the last few years, that is to say, has the standard reached been higher than it was formerly?—Up till last year I think it had, certainly, but last year a change of system was introduced which prevents my forming a very definite opinion as to the result. Three months hence, I think that I shall be able to form a better opinion. The change was, that no one is now allowed to pass the higher examination until he has come up for and has passed the lower. Most of the candidates that I examined last year had only studied the subject in an elementary manner, so that it is not easy to compare last year with former years. The number of rejections in the lower stage was very considerable last year, but I do not think that it would be right to compare it with previous years, and up till last year there had been an improvement from year to year, I think.

4885. Was that alteration made with your approval?—Yes, certainly. It was discussed at a meeting of examiners, and I think it was an advantage.

4886. Did a considerable number of young men offer themselves for examination in botany?—The number last year was something like 500 in the two subjects taken together.

4887. Have you any suggestions to make as to any alterations which you would think it desirable to introduce into the present system?—As an examiner, I have rather got to administer the present system; I know

gives a man an insight into a new world, although it may not enable him to see very far.

4876. Then you would not like to see it discontinued in any case for pass-men?—I would not venture to say that it should be insisted upon where you had the prospect that great attainment in another department might be procured by the sacrifice of it: but I should in the average of cases.

4877. (*Dr. Sharpey.*) Do any considerable number of students trained at Balliol College eventually become teachers in institutions out of the University altogether; for instance, in schools?—Yes, a good number.

4878. Seeing that there will be now much more attention paid to science in the endowed schools, do you think there is much prospect that you may have young men preparing themselves to give instruction in science in the University of Oxford?—Looking to the future I think there is great hope of that. And altogether there is a prospect of considerable change in that present condition of things on which my opinions have been founded.

4879. (*Chairman.*) Is there any other matter upon which you are prepared to give the Commission any information?—I think not.

very little of the working of it. One has not the means of knowing what the nature of the working of the system is; we do not know the teachers and we do not know the pupils.

4888. So far as you can judge from the answers, do you think that many of the candidates have trusted to cramming rather than to a sound knowledge of the subject?—In many cases, but that varies with the teachers; indeed, I may say, it varies exceedingly. In some cases the amount of rejections is 75 per cent., and in other cases the number of men who pass is 75 or 80 per cent. I can always trace the connexion between that proportion and the teaching.

4889. A certain number of persons have undertaken, as you would infer, to teach the subject without a competent knowledge of it themselves?—Yes, I think so; without a practical knowledge.

4890. That involves a considerable waste of time, does it not, for the young men and the youths, who imagine that they are studying botany?—In some cases I am afraid it does.

4891. Do you think that any regulations might be adopted which would tend to restrict the teaching to persons who are really able to give instruction with advantage?—There is always a system of examination for teachers. I do not know whether that applied to the very earliest periods of the system or not, but now, instead of being a separate examination, the teachers merely pass the highest grade of the ordinary examination, and, therefore, the examiner has not got the same means of testing the qualifications of the teachers that he had before.

4892. There was formerly a special examination for teachers, was there not?—Yes; when I began as examiner there was a special examination for teachers, which has since merged in the one great examination in May.

4893. But a certain number of teachers appear to be competent, and I suppose some even of those have passed that examination?—That I cannot tell; we have no means of knowing when the teachers passed. I have got certain incidental means of finding out. This year they tied up their papers in bundles, which gave me a clue to the schools which they came from, and previously to that, from my sending them specimens of living plants to describe, I had a certain means of ascertaining from which schools the papers came. They were obliged to tell me the number. When I say obliged, I do not mean to say that they would have refused the information in any case, but that it was necessary to give me the infor-



mation in order that I might send the necessary specimens of plants for description.

4894. It is not thought desirable, as a general rule, that the examiner should know the schools from which the papers come?—That is the system; we are not told, and I suppose the object is that we should be perfectly unbiassed in the examination.

4895. There are no classes in London or elsewhere for training teachers as instructors in botany, are there?—No, none that I know of. In all the schools of medicine in London, there are botanical professorships or lectureships, but not specially for the training of those teachers.

4896. (*Dr. Sharpey.*) Do you know what the average age is of the candidates that you examine in botany?—I have no means of knowing, except from this paper which I have in my hand, which gives me the ages of the passed candidates; it does not give any information at all about the ages of the rejected candidates, which I should infer probably to be, in most cases, on the average, considerably less than those of the passed candidates. I judge, rather, from the writing and spelling of the rejected candidates, that many of them are very young children. There is one exceptional case of a girl of eight, who has passed in the elementary stage. I think it is a subject which you can teach more advantageously to young children than most other subjects.

4897. What opinion have you formed as to the suitability of systematic botany and descriptive botany, on the one hand, or vegetable physiology, on the other, as subjects for instruction to young persons as contrasted with other studies?—I think there is no other branch of natural science which can be so well taught to young children as botany can, because the text book is always at hand, and specimens can always be got in the summer time, the text book being the country.

4898. (*Professor Stokes.*) Would you include vegetable physiology in that?—No, I would not include that as a branch to be taught to young children. I would draw a distinction broadly between the two; that is a more advanced subject, and more difficult to begin with.

4899. (*Dr. Sharpey.*) If I understand you rightly, I think you examine by means of specimens?—I do in systematic botany.

4900. And you require candidates to describe them?—Yes, I require them to describe those specimens.

4901. And to assign to them their place in the system?—Yes; at least, when the specimens belong to the best known large British orders. I generally give two specimens to be described, and there are usually six or eight or ten other questions, making, therefore, one fourth or one fifth or one sixth of the whole to depend upon the description of the living plant.

4902. And, from the character of the written answers which you receive, can you discriminate whether the knowledge has been gained from actual study of the subjects, or from books chiefly?—I think there is a fair proportion of cases of those who pass, taking one school with another, in which they have been taught from living specimens. I have no doubt that in those cases in which I reject a very large proportion of candidates, it is certainly mere cramming, mere book teaching.

4903. Does it appear to you that in cases where there has been a large proportion of rejections the fault is in the teaching?—The fault, I think, if I may make a guess, and it can only be a guess, is in the teachers themselves not having been properly taught, but I reserve, of course, the fact that I have never seen one of those teachers in my life to the best of my knowledge and belief.

4904. As you have said, a teacher must have passed a high examination himself?—Yes, he must have passed the first-class of the advanced stage, as it is now called.

4905. In every subject in which he undertakes to

teach?—Yes, in every subject in which he undertakes to teach. I so understand it.

4906. Do you see any prospect of improvement in the teaching generally, or in what way it might be amended?—That question I answered, I think, indirectly, a few minutes ago in saying that this year is so different from previous years in respect to the system that you cannot quite compare them. The candidates this year are almost all second class, and they have only come up for the elementary examination, but of the 127 who passed in the second class, as against 205 who failed, a very large proportion will probably come up this May in the first class, and I do not doubt that then I shall have an opportunity of contrasting them.

4907. My question was rather to learn whether you saw any means of improving the teaching of the subject through the masters, by giving them better instruction and preparing them better?—I suppose that the remuneration for teaching botany (I am going, perhaps, into a subject which I have no definite means of knowing) is so small that there is no great inducement to masters, as a rule, to study it in the places in which it can be properly taught, and, therefore, they get the information themselves mainly from books; but, of course, with the occupations and heavy work of the science teachers, who, I am led to believe, are also often teachers in the ordinary elementary branches of education, reading, writing, and so forth, they have not got the time and have not got the means of giving the proper amount of study to the subject.

4908. (*Sir J. P. Kay-Shuttleworth.*) Some time ago, there was a special examination of teachers, as to their competency to give instruction in botany?—Yes, in all subjects, as I understand. That took place in November. I think there were such examinations for two years after I became examiner, but after that it was discontinued.

4909. Did that examination include the description and identification of the botanical specimens which were laid before the teachers?—Those teachers who came forward for a certificate in systematic botany, were always examined with specimens, but those who came forward in vegetable physiology I did not examine practically in the description of plants; they would have objected to it at that time.

4910. Can you call to mind what proportion of rejections there might be for insufficient acquaintance with botanical specimens?—I cannot at this distance of time.

4911. Was the proportion large or small?—That is information which could be got either from the Department or from my papers, but I have not got the means of answering that question at present.

4912. At that time, was a certificate given for botany separately from any other study?—Yes.

4913. It was not grouped with other studies, so as to require that the teachers should have a knowledge of collateral subjects?—No. To entitle the teachers to payment for the candidates who passed in botany, it was necessary that they should pass an examination in the two sections of the subject, vegetable physiology and systematic botany.

4914. So that a teacher who passed that examination might teach the subjects in which he was examined, either solely or in connexion with any other subject, according to his own discretion?—So I understand the system to be.

4915. Since that time, a student who has passed in the country in the ordinary advanced class may become a teacher of botany, may he not?—Yes, one who has passed in the first class of the advanced stage.

4916. So that you have, yourself, now, no other control than a general examination, over the attainments and character of the teachers who are the instructors in botany in the country?—No, and, if I may be permitted to add, in a single examination which gives honours, which is for the teachers, and which is also for young people, it is very difficult, I do not say impossible, to set a paper which shall be

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sufficiently comprehensive to test all classes of candidates.

4917. Should you think that the tendency of the system of the examination of teachers which has been recently introduced, would be to elevate the character of the teachers as respects their attainments and competency or otherwise?—I prefer the old system, I think.

4918. The tendency of the new system would rather be to admit persons who were less carefully prepared than those who passed a special examination under the old system?—I think so, but I cannot say that it is the fact. I think that that is its natural tendency.

4919. As respects your own experience, and judging from the quality of the papers that have come before you as examiner, do you think that the students were better taught by the teachers prepared under the former system than under the latter?—No, I think that there has been a gradual improvement in the teaching since I became an examiner, certainly; but the improvement might have been more rapid, possibly, if the old system had been adhered to; but it is so very difficult to answer, indeed, with my knowledge, it is impossible to answer that question with anything like exactness.

4920. You said that, with respect to certain teachers, 75 per cent. of their scholars were rejected, and with respect to other teachers 75 per cent. were admitted; have you any means of discriminating whether such teachers have passed under the old system or under the new?—No; I have no means of judging, the Department have of course. I only know the teachers from the names of those who pass. I have no means of knowing by whom the rejected candidates were taught.

4921. Do you know during what months in the year students in classes of botany in the country which you examine are ordinarily taught?—No, I do not, but in winter, I am afraid.

4922. If it were the fact that they were taught in the winter, and likewise in the evening, would you think that the teachers would ordinarily be furnished with herbaria to enable them to give practical teaching?—No, I do not; but I think that even an herbarium would be an insufficient substitute for real practical teaching in the field, either out of doors, or by bringing living specimens to the pupils.

4923. At least, if they were taught on winter nights, they would have no opportunity of field instruction?—I am afraid not.

4924. In such a case, the instruction given by the teachers must, on the whole, be that which they have themselves derived from books, and must be almost exclusively oral?—I should suppose so.

4925. Does not such a system, coupled with the inducements that there are on the part of the teacher to increase his emoluments by passing the scholars, necessarily tend to a system of cramming?—In many cases it does, I have no doubt.

4926. Do you attach very much value to that mode of instruction in botany?—No.

4927. As respects a science of observation, can it be efficiently taught from books?—No, not to elementary pupils.

4928. The faculties which a science of observation is intended to train, and by which its highest utility is attained, cannot, I presume, be exercised without observation itself?—It cannot, I think.

4929. It must, therefore, to a great extent, be illusory to teach botany in the evening winter classes from books without specimens?—I think so, certainly.

4930. If you were to devise a system of teaching botany, you would certainly desire that the pupils should be taught in the field from the book of nature in the summer, and in the day time?—Certainly. It need not be daily; it might be on the weekly holiday of the pupils.

4931. Would it not be a wholesome regulation, that botanical classes should be held in the spring and summer months only?—I think so, certainly, as

regards elementary botanical classes; vegetable physiology might be taught at any time, and my suggestion last year to the Department was that no one should be allowed to study vegetable physiology until he had passed his examination in systematic botany. No doubt that would diminish the number of candidates very much in the first instance.

4932. Supposing a schoolmaster to be occupied three hours in the morning and three hours in the afternoon with his elementary school, and to have the charge of teaching pupil teachers for one hour and a half during each day, and then, during, probably, two evenings in the week, to have the charge of an ordinary elementary evening class, would you think that the instruction of a class of botany by such a man, in the winter evenings, without the use of specimens, was of much importance?—No, not of systematic botany, certainly.

4933. (*Sir J. Lubbock.*) Do you consider that the teaching of botany might be introduced with advantage into the elementary schools, generally, of the country?—So far as I am capable of forming an opinion, I think certainly it would be the first branch of natural science which could be with great ease taught to young children; and, with good teaching, it would be most attractive and most interesting.

4934. I infer, from a previous answer, that you do not think that the children in our elementary schools are too young to derive advantage from the study of botany?—I think not.

4935. I think you said that you considered it best to take systematic botany first, and vegetable physiology at a later stage?—I think so, decidedly; in fact I have suggested that to the Department.

4936. Do you attach a high value to botany as a means of mental cultivation?—One does not like to speak very strongly with reference to one's own profession, but I have heard teachers of other branches of biological science, and amongst them Professor Huxley, profess a very strong opinion in that sense. It is my own opinion, as I have already said, that it is the first science that young children can be taught.

4937. I presume that a botanical examiner can detect cramming, can he not?—Yes, in a large proportion of cases; I have had several instances of it in my examinations. I have had one remarkable instance in which a series of 30 or 40 papers have been found to be dictated and learnt entirely by rote, and the way in which I first found that out was, that the teacher had made a mistake, and every question was wrongly answered simply because the teacher had made a mistake in his note book. The subject was investigated by the Department, and they sent me up the note book.

4938. In fact, you think that cramming is as easy to detect in botany as in any other subject?—I think so.

4939. There is no special objection to botany, as a means of instruction, on the ground of its being particularly liable to cramming?—No, certainly not, in my opinion.

4940. (*Chairman.*) The Department gives no assistance, I believe, to teachers in the way of apparatus. Is not the possession of a microscope a great advantage, or is it essential for teaching botany?—It is not essential for the very elementary stage of systematic botany, although it is a great advantage, I think, certainly, and if the system extends, as I hope it will do, it ought to be an essential piece of property for every science teacher. I mean a simple microscope, not a very powerful one.

4941. (*Sir J. Lubbock.*) But, for ordinary botanical work, a hand microscope is quite sufficient?—Yes.

4942. (*Chairman.*) Do you think that teachers generally do possess a microscope of that description?—I cannot answer that question at all of my own knowledge.

4943. Is there any other point on which you could furnish the Commission with additional information respecting those examinations?—I think not. The



papers which I have brought with me are merely the departmental abstracts of reports, all of which are in the hands of the Department of Science and Art.

4944. Do you know the number of teachers in

elementary botany connected with the Science Department?—I think there must be about 30 or 40.

4945. Is the number increasing?—I do not know that.

The witness withdrew.

Adjourned.

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Esq., M.D.,  
F.R.S.*

7 Dec. 1870.

No. 6, Old Palace Yard, Westminster, Thursday, 9th February 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

The Reverend WILLIAM HENRY BATESON, D.D., examined.

4946. (*Chairman.*) You are master, are you not, of St. John's, Cambridge?—Yes.

4947. You have also taken an active part in university affairs for many years?—Yes.

4948. And have frequently been on the council of the senate?—Yes.

4949. It is the case, is it not, that certain measures have been taken both in the University and in the colleges for some years past, having for their object to encourage and promote the study of natural science?—Yes. Perhaps I may be allowed to observe that I do not attend as a volunteer, but I shall be happy to give any information that may be desired. I have no particular question that I wish to mention with any degree of emphasis, except the propriety of some measures being adopted for contributions from the colleges to the University. That is our pressing want, and it is a want which was endeavoured to be provided for by the Commission, both the Royal Commission and the Executive Commission that was afterwards appointed; but from various causes it failed, and the university has since then raised money by a capitation tax, but that has only extended to a certain amount, and it is felt to be rather oppressive to persons who are dispersed over the country, and who are not actively employed in the University; and as the colleges are wealthy and the University is poor, it is felt by most persons in the University that it would be a very desirable thing that some scheme should be adopted for raising funds, not merely for scientific instruction, which this Commission especially takes under its care, but for all kinds of instruction in the University.

4950. Have you any particular scheme which you would recommend for adoption?—There was a particular plan drawn up, both by the Royal Commission, of which I was secretary, and by the Executive Commission, a per-centage plan; and since then there has been what we call a syndicate, a committee which was representative in his character, that is to say, every college contributed at least one member, and the immediate ground upon which that syndicate was appointed was the special consideration of a professorship in physical science. That had been recommended by a previous syndicate, and then this representative syndicate was appointed for the purpose of considering the ways and means. They drew up a report, which I daresay the Commission have seen, and suggested alternative methods of raising the money. This was communicated to the colleges, but the answers of the colleges were not sufficiently favourable to induce the syndicate to think that at that time at all events (that is, last year,) any particular plan could be adopted. My own idea is that opinion is nearly ripe in the University for some legislative enactment, (it could not be done I think, without an Act of the Legislature,) to raise a certain per-centage, or some definite sum, from the college funds, to be devoted to defined and

specific objects in the nature of a trust; and if that were coupled with power to the colleges to suppress fellowships, or to raise the money in the manner that might be most convenient, with a view to their immediate circumstances, I do not apprehend that there would be any great opposition to such a plan. If one or two persons were entrusted with a power of inquiry, and after inquiry of regulating and ordering the specific mode of contribution, I think that that could be brought to pass without any very great difficulty.

4951. Would you suggest that the method of carrying this into effect should be embodied in an Act of Parliament, or that the necessary powers should be given to certain individuals?—I should prefer the latter mode. I think that if that were done in the Act of Parliament there must be an inquiry beforehand, or there must be an inquiry before a committee of the House of Commons or the House of Lords, which would not be so agreeable, I should think.

4952. Would you contemplate a considerable portion of the college funds being appropriated to the general purposes of the University?—The sum which I thought at an early day would be wanted would be somewhere about 10,000*l.* a year.

4953. Do you know, speaking roughly, what the income of the colleges is?—No, I do not. We estimated it on the old Commission at 180,000*l.* net, I think, but we had not the evidence of all the colleges.

4954. The income of some colleges has rather been increasing of late, has it not?—There has been a disposition to run out leases, and there have been other sources of increase, I suppose.

4955. There are a good many purposes, I presume, to which, in your opinion, this money could be beneficially applied if it could be obtained?—I think it might then go to the professorships or sub-professorships. I think that the University would be able to provide money for museums and for its ordinary current expenditure, but I think that it would be best to devote this to the salaries of the professors. I may say that one of the great objections which has been urged against college contribution to the University is that the University is not a very economical administrator of funds. The University is liable to importunities of various kinds, and it has not a very strong power of resistance, and the colleges have been, I think, so far as economy and frugality are concerned, very good administrators.

4956. And you think that there is a suspicion, to a certain degree well founded, that the University is not very economical in the expenditure of its funds?—I think when any feeling springs up in the University that some object external to its main purposes requires a sum of money, it is difficult to resist a memorial or any application that may be made for such grants. Nobody is so immediately concerned

*Rev. W. H.  
Bateson, D.D.*

9 Feb. 1871.



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9 Feb. 1871.

with regard to the beneficial interest of the expenditure as they are in the colleges.

4957. Are there in your opinion any very pressing wants as regards instruction in science?—There is the new museum, which is entirely, as yet, to be begun.

4958. And you contemplate the establishment of new professorships?—Rather the power of provision for those that exist, I think is the more urgent want. For many years past our professorships were only 100*l.* a year, they are now raised most of them to 300*l.* a year, which most persons would consider to be quite inadequate. Two or three have been raised to 500*l.*, but I think most persons would be glad to see them raised to 800*l.*

4959. Do you wish to see professorial instruction assume a position of greater importance in the University relative to tutorial instruction in the colleges?—I think that both systems would always have their separate field of usefulness. I am no great believer in the professorial instruction for the ordinary regular work of the University, that is to say, for the examinations and for the preparation of young men. I think there always will be an inferior class of teachers who will have to do the laborious work, the mere manipulation, as it were.

4960. Are you able to say how many colleges have evinced a favourable disposition towards submitting to taxation?—The statute of the Commission was incorporated in four colleges only, that is to say, it was not negatived by four. The Act of Parliament gave a negative voice to two-thirds of the society in each case, and two-thirds negatived it in 13 of the colleges. The answers that came from the colleges to our syndicate I think showed a much stronger disposition to accept some plan, but then we prudently did not submit one plan only. We gave an alternative scheme.

4961. Was the nature of the objection stated by any of the colleges?—Yes, they stated that they would not contribute to the professorial teaching in two or three of the colleges at all. Then I think in two or three instances they avoided stating any particular ground of objection; but speaking roughly, I should think that about half of the colleges then indicated a general willingness to do something; but they did not come in to any specific plan.

4962. I think we have heard that one objection which has been felt to any taxation of that kind was that it would press unfairly upon some of the poorer colleges. Have you ever heard that expressed?—No, I never heard it. The smaller colleges are now placed in a difficulty in consequence of the great increase of subjects, and the increase of our triposes, and the different modes of examination; they cannot supply the teaching power that is required, but they have established a kind of union of colleges for the purpose, and I think that that will be likely to spread; and as our plan was a percentage I do not know that it could be oppressive to a small college more than to a large one.

4963. Do you mean that the fellowships in some of the colleges are much less valuable than in others?—That I am not able to say, but they were all reviewed at the time of the Commission, and their numbers were reduced or altered according to their pecuniary circumstances, I think. I should not suppose that there was any great difficulty arising from that; formerly there were a number of almost nominal fellowships, but I think none of those exist now.

4964. Do you think that any general dislike would be entertained to a reduction in the number of fellowships?—No; I have heard suggested as a mode of meeting this particular want, that the easiest plan would be to give to a college the power to suppress fellowships for that purpose. I think there might be other colleges who would wish to retain their number, and would rather meet the difficulty in some other way. Some have suggested giving a specific sum of money to the University, so as to get clear of the investigation of accounts, or anything like an annual visitation. I have heard that objection urged.

4965. Do you yourself see any great objection to a

certain diminution in the number of fellowships?—No, I should not think that would be objected to. One of the great wants that we experience at Cambridge is a want arising from the large number of non-resident fellowships, fellowships that may be retained in many instances for life, and where the person holding the fellowship may be said to be entirely unconnected with the University, except from his having at a particular time of his life obtained a particular position in our examinations.

4966. Should you be unwilling yourself to see any restrictions adopted upon the present system of fellowships being held for life by non-residents?—I think that some alteration in that respect would be very desirable.

4967. Would the feeling in the University be strongly against it?—I am not able to speak definitely upon that point. I do not think that there would be a disposition, at all events no general disposition, to diminish the value of non-resident fellowships, as such; but I think it would be quite possible to do as has been done in some of the colleges, namely, to have fellowships on a different tenure, that is, some held for a term only, with liberty to marry, and so on, and perfect freedom, but with only a defined and limited tenure. That has been adopted, and I believe from what I have heard it has worked very favourably. Of course the financial circumstances of the college would have to be considered, but I presume that the college would be empowered to make up the deficiency in some other way if they thought proper.

4968. Have you the power at St. John's of calling upon any of the non-resident fellows, if the society were so disposed, to come and reside and take part in the University teaching?—Not under the present statutes. Under the old statute we had, but not under the present. A man is perfectly free so long as he complies with the restrictions with regard to degree and with regard to ordination.

4969. (*Professor Stokes.*) Did I understand you to propose that Parliament should fix a certain sum as a maximum, or a certain sum absolutely, to be raised from the colleges, or a certain per-centage of their revenues?—I do not propose either the one or the other, but I think that any one of those plans is feasible. I really do not think that it is of so much consequence what plan is adopted as that some plan should be adopted.

4970. Would you like the sum to be raised in that manner to be determined in one of those ways, or assign a maximum, and empower a certain body to raise money up to that maximum according to the wants of the University?—I should rather leave it entirely open. I think that there ought to be a commission or an arbitrator appointed to listen to what would be most convenient to the colleges, and also to listen to what is wanted from the University. My idea is that what is required at present would be something like 10,000*l.* a year, but of course money is of variable value, and I would not fix it at a specific sum. I see no objection whatever to a per-centage, but I think it ought to be dependent upon further inquiry.

4971. As to the mode of apportioning this sum between the different colleges, would you have that done by a rule laid down by Parliament, or would you empower a certain body of men to arrange that from time to time?—I would rather have it done once for all.

4972. (*Professor Huxley.*) Did I understand you rightly to say that the University is rich enough to supply the funds for the maintenance of the museum required at Cambridge?—It would be, I think, if it were relieved of the salaries that are now paid to the professors. I do not think that it is so at present. I daresay you know that the endowment revenue of the University is scarcely anything. The funds that we administer through the University are nearly all raised by degree fees or by capitation taxes.

4973. And out of that you have to pay the professors at the University?—Yes, those that have not got separate endowments; but for the purpose of this



Commission the endowment may be considered as inconsiderable, very small indeed.

4974. Then I understand that you propose to raise the sum from the colleges for the payment of professors, and then to apply the funds which the University would have left to the maintenance of the museum?—Yes, and of its examinations. We have a great number of other expenses, disciplinary expenses and examination expenses, and the maintenance of our buildings.

4975. Do you think that the sum you have mentioned would be sufficient, because museums are very costly affairs?—They may be of course extended to any amount, but I should contemplate a great relief to the University chest.

4976. (*Sir J. P. Kay-Shuttleworth.*) Taking into account that the estimated annual income of the colleges is reported to be about 180,000*l.* a year, would you think 10,000*l.* a year an adequate proportion of the income enjoyed by the colleges to be applied by the University to the teaching of experimental science?—I should say so. I should think it would be enough, that is to say, if the colleges are to be maintained at all in their present way.

4977. Do you think that it might be desirable to have some change in the body in the University which would have the control of such funds?—No. I do not imagine that that would be necessary. The funds of the University are administered by grace of the senate. The council are a small representative body of 17 persons, and every vote must pass that body, so that every interest is to a certain extent represented.

4978. Supposing that the museum were to be extended, that grouped around it there was a professoriate, and in connexion with that there was subordinate instruction by demonstrators and others, and that laboratories were founded in which individual instruction was to a considerable extent given, would such a body grouped round such a museum be adequately represented in the existing governing body of the University?—There is at present a representation of the professoriate. There are four professors necessarily on this council. The council consists of four heads of colleges, four professors, and eight other persons who are elected to serve for four years. Those 16, with the vice-chancellor, form the council.

4979. So that the central instruction in experimental science, conducted as I have attempted to describe, is represented, in fact, in the governing body of the University?—It is or might be. Experimental science has hitherto formed a very small part of our system, but if it became an important one I apprehend that its interests would be regarded in the biennial elections.

4980. And you would consider such a representative influence to be desirable?—I should think it would become so as the school grew up to any importance.

4981. (*Marquis of Lansdowne.*) I believe that science now occupies a much more important position in the curriculum of the University than it did a few years ago, and that great efforts have been made in the cause of science recently?—They are being made, rather than have been made, I think.

4982. They have been made so short a time that it would perhaps be scarcely fair to ask you whether the success of those efforts has been at all commensurate with the magnitude of the efforts?—It is too soon to speak of any great efficacy at present. The principal change that has taken place has been with regard to the pass examinations.

4983. Have you any opportunity of judging whether the persons who have passed in the science examina-

tion do so merely as an alternative of evils, or with any real desire to obtain scientific culture?—I am afraid, with regard to the pass examinations, that I cannot say much about the love of the pursuit, but I think it is too soon to speak with any confidence about that.

4984. In your opinion, is the object of the teaching of science at the University rather to serve the purposes of general culture, or with a view to technical or professional pursuits?—I should say both. I am told that there are at present several persons attending our chemical school who do not intend to remain for the degree, but who come from the love of the thing and from the desire to acquire information. There are several persons who have merely taken a year at Cambridge in that way, attending Professor Liveing's lectures.

4985. (*Professor Smith.*) Would you be so good as to tell us what has been done recently in your own college with the view of providing instruction in natural science?—We have for a long time had a chemical laboratory (I may say for nearly 20 years), erected for Professor Liveing after he became a fellow, and it has gone on very actively ever since, and we added to that the geological lecture. Those are the two lecturers that we have in natural science.

4986. There is not a lecturer in experimental physics, I believe?—No.

4987. Are fellowships in your college attainable by merit in the natural sciences in the same manner as they are attainable by merit in mathematics or in classics?—I may say with great confidence that both by statute and by practice we wish and we do, and we are directed to put everything on an equality with regard to that. Perhaps the most *à-propos* remark that I might make with regard to that is that we elected a man for Oriental knowledge, although he had not distinguished himself in any examination of any kind in the University; but we got certificates from experts upon that particular point, and he was elected to a fellowship although he merely took an ordinary pass degree. He was elected first to a foundation scholarship. I am speaking of Mr. Palmer, who has been out in the East. We have no instance of that kind with regard to natural science, for there has been no such case; but if there had been such a case, that is the kind of principle upon which we should have been disposed to act.

4988. With regard to the University generally, is there any impression, that you are aware of, that the men who study natural sciences are less likely to obtain a fellowship than if they devoted themselves specially to mathematics?—I should say none whatever; but there has been a difficulty in satisfying ourselves that the persons whom we have had as candidates have come up to what we consider the fellowship standard, but there have been one or two that have been so elected.

4989. (*Chairman.*) Is considerable use made of the laboratory at St. John's?—I believe it is so full that they have no space at all, and it would be better if it were larger.

4990. Do you admit students from other colleges?—Yes.

4991. Is the lectureship in geology newly established?—It is about two or three years old.

4992. Are those lectures given in concert with those of Professor Sedgwick?—No, I think they are quite independent.

4993. Are there any other points upon which you wish to state anything to the Commission?—I think not.

The witness withdrew.

The Rev. WILLIAM HEPWORTH THOMPSON, D.D., examined.

4994. (*Chairman.*) You are master of Trinity College, Cambridge, I believe?—I am.

4995. Trinity College has lately adopted some measures, has it not, with a view to the promotion of certain branches of science?—Yes, of certain branches of experimental science.



Rev. W. H.  
Thompson,  
D.D.

9 Feb. 1871.

tation in the science of pure physiology. It was mentioned to us that that was the branch of science which was least represented in the University, and, indeed, in the kingdom at large, and that we should be doing a service to science generally by making this appointment. Dr. Foster was not a member of our university, nor of Oxford. We have also founded a lectureship in physical science, and a gentleman whom I believe you will see to-day, Mr. Trotter, gives lectures which are not confined to our own undergraduates. We have fitted up a lecture room for him, and furnished him with the apparatus which he considers necessary for the purpose of his lectures, which are on heat and electricity.

4997. Has the prelector of whom you spoke yet delivered any course of lectures?—Yes, he delivered a course of lectures last term, if not more than one; he lectures in buildings belonging to the University, which the University has lent for the purpose, and he has the use to a certain extent of the University apparatus, I believe, but we have furnished him with the means of providing himself with the apparatus which is necessary in order to give his public lectures and explanations. His stipend and allowances are not far short of 600*l.* a year. He has rooms in college, he has commons in hall, and he has all the outward privileges of a fellow. He is not a fellow of the college, but his advantages are those of a fellow, except that he takes no part in the government of the college.

4998. Are you able to state to the Commission how his lectures have been attended?—I understand that the attendance has been satisfactory. The medical students naturally go to him, and there is an increasing number of medical students, and others no doubt will attend who wish to distinguish themselves in the natural sciences tripos.

4999. The University as a University has also taken certain steps, has it not, of late years towards promoting the study of the natural sciences?—The University has exerted itself as much as possible in that direction. Its means are limited. The University of Cambridge is not a rich body, though more so than it was a few years ago; but the only way in which it can increase its income is that of taxing its members, and that obviously is a process which cannot be carried on indefinitely.

5000. Do you think that additional funds are required for University purposes?—I am very strongly of that opinion, and always have been so, both in the interests of literature and of science.

5001. Can you inform the Commission how in your opinion those funds can be best obtained?—I should say that the simplest plan would be that which the University Commissioners proposed, but failed in carrying out.

5002. To what extent would you like a contribution to be made from the colleges; how large a sum annually do you think it is desirable should be furnished by the colleges to the University, or are you unable to fix any definite sum?—I would rather leave that to experts.

5003. I understand you to say that for other purposes besides scientific purposes you think it desirable that funds should be contributed from the colleges to the University?—Yes, for professorial purposes generally; and I should include in professorial purposes the furnishing of museums and apparatus of different sorts; but the literary professorships are not what they ought to be. There are important branches of literature that are very insufficiently represented at present.

5004. You refer rather to the insufficient endowment of existing professorships than to the necessity of any additional professorships?—I refer to both.

5005. Then you think it is desirable that a considerable sum should be placed at the disposal of the University?—I think a considerable sum. The proportion of distributable College income named by the Cambridge University Commission was five per cent., and I think that that would be sufficient.

5006. That would raise something approaching to 10,000*l.* a year, I believe?—Probably; and the amount would increase as the incomes of the Colleges increase.

5007. You think that that would be sufficient to meet all the requirements of the University?—I am disposed to think so, if it were properly husbanded. I should not approve of leaving its distribution entirely to the discretion of the governing body of the University for the time being, I think that there ought to be some permanent committee or syndicate to watch over the distribution of funds of that sort.

5008. Do you think that opinion in the university generally is prepared for the adoption of a measure of that kind?—In my own college we have always expressed our willingness to contribute our proportion; in fact one of our statutes enables us to tax ourselves to the amount of five per cent., and we should have done so long ago if the other colleges had been willing to do the like. Some colleges, I believe, acceded to the desire of the Commissioners, and have such an enabling statute in their statute-book; but others, and those important colleges, have not. I may mention that we have at present the power of contributing to the scientific needs of the University, and that not many years ago we offered the University 4,000*l.* on condition that a proportional amount should be subscribed by other colleges. Peterhouse also offered a large sum. I am not aware how many of the other colleges followed the example, but the thing was not carried out for want of a *consensus* of the colleges. I believe that public opinion is advancing further in that direction than it was at that time.

5009. Do you think that there is much probability of the colleges gradually of their own accord adopting a proposal of that kind?—Not all, I think. Probably the majority will do so, and those the most influential, perhaps; but I think there are colleges which will not.

5010. Probably nothing will be done until all agree to pay their quota?—Nothing will be done till all agree. In addition to the injustice, the amount would be inadequate if it were raised from the willing colleges only.

5011. Would there be much feeling in the University against any interference on the part of the legislature in this question?—I am afraid I am not a very good judge of that. I have no doubt that strong language would be used in some quarters.

5012. (Sir J. P. Kay-Shuttleworth.) With a view to raising the funds for the central instruction in experimental science by the University, would you think it desirable that the colleges should have power to restrict the duration or to limit the number of fellowships?—I do not see how the restricting of the duration of fellowships would help; they are already restricted in my own college to eight years, except in the case of clergymen and of certain officers; they are not so in all colleges, but in the majority there is some restriction.

5013. Would you limit the number of non-resident fellowships?—It has been proposed to levy a tax on non-resident fellows, as an alternative of taxing the colleges *en masse*.

5014. With a view to meet the taxation of the colleges would you think it reasonable to grant the colleges power to limit the number of the fellowships?—Speaking of my own college, I do not think we should like to diminish the number of our 60 fellows. In evidence which I gave to the Cambridge University Commission, I expressed an opinion that our college might be called upon to give a certain number of fellowships or senior fellowships (which in those days were of double the value of the ordinary fellowships) to found professorships in the University. I had an opinion at that time that this would be a proper application of our funds, because at its foundation the college was required to supply what was then an adequate stipend to the three regius professors of Greek, Hebrew, and divinity. Greek in those days was considered the most "advanced" of all studies, and Henry VIII. insisted very much upon the teaching of Greek in Cambridge and elsewhere.

5015. Would not the application of certain of the fellowships, for example, of Trinity, to the endowment of the professoriate of the University have the practical



effect of limiting the number of non-resident fellows?—It would, provided that as professors they were bound to residence.

5016. In that way therefore you are not averse to the idea of requiring to a greater degree service within the University from the fellows who are at present non-resident?—In principle certainly not. Whether I should agree to any particular scheme I cannot say. As master of a college I hold the same relation to non-resident as to resident fellows, and I feel a certain delicacy in expressing any opinion upon the subject.

5017. You have stated that in your opinion it would be desirable to have a permanent syndicate to watch over the distribution of any fund which would be derived from the colleges in its application to instruction in experimental science by the University. Have you considered and can you advise the Commission as to the constitution of that permanent syndicate?—I think that the University would very easily devise such a syndicate. The professors should be represented, but not only the professors; I think that persons of consideration in the University should be members of it, and also persons of some financial ability, of whom there are several in the University both professors and others.

5018. But having regard to the growth round the museums and the laboratories of the University, of a professoriate with assistant professors, you would consider it proper that that professoriate should have representation in the permanent syndicate?—Yes, and no doubt it would have. The syndicate could not act without information which it could only get from experts.

5019. In that way you would conceive that you would get an improved governing body?—No, not a governing body, but a body to advise the governing body.

5020. (*Dr. Sharpey.*) If I understand you rightly, the prelector who has been appointed, namely, Dr. Michael Foster, has not only the duty of delivering lectures, but also of giving practical instruction in his subject in a laboratory?—He does so.

5021. Do you think that any considerable number of persons now go through scientific studies in Cambridge, or are likely to do so, with a view of teaching those subjects in the more important schools?—I have no doubt that a certain number do.

5022. And that Cambridge in short would offer a field of study and of instruction for such persons?—I hope so, indeed. I could mention persons who have gone out from the University of Cambridge who are holding precisely the situations of which you speak in important schools, both public and otherwise.

5023. Important schools in which the teaching of science will take a larger development?—Yes, and I think it very important also that scientific men should have had a general University training.

5024. (*Professor Smith.*) In recent times have any fellowships been awarded in your college for excellence in the natural sciences, and is there a system of examination which renders fellowships accessible from time to time to students of the natural sciences?—We have had to institute a special examination for the purpose. You are alluding probably to the fellowship that we gave away last autumn, which was rather incorrectly called a science fellowship, being offered for proficiency in certain sciences of observation and experiment, not included in the ordinary curriculum, which includes

moral and mathematical science. We have done that, and we also set apart a scholarship or two every year for the same purpose. Perhaps I may be allowed to put in the following document as bearing upon that subject:—

“Trinity College, Cambridge, February 8th 1871.

“At the examination for foundation scholarships held in the week after Easter, one or more scholarships will be obtainable by proficiency in the natural sciences. Should one scholarship only be so assigned, preference will be given to the candidate who shows the greatest proficiency in physiology and the allied subjects. The examination in the natural sciences is open to all undergraduate members of the Universities of Oxford and Cambridge.

“The days of examination will be Monday, April 10th, and three following days. Candidates are required to send in their names to one of the tutors on or before Saturday, March 25th.”

5025. The fellowships seem to be given to natural science only regularly, and not occasionally?—The scholarships are given every year, the fellowships occasionally. We happened last year to have a large number of fellowships to dispose of, and we gave one exclusively for superiority in the non-mathematical sciences.

5026. That was the first instance, was it not, of election on the ground of non-mathematical science?—It was. We never before had a man of our own, highly cultivated in other respects, who merited a fellowship for proficiency in that class of studies. Such men are not at present to be met with every year. We consider that the natural science scholarships are a permanent institution, and we give one or two every spring, not only to members of our own college, but to members of any other college in either University. But the qualification for a fellowship is naturally higher than that for a scholarship.

5027. Is the competition for the scholarships found to be satisfactory, and are the candidates, generally speaking, young men of ability?—I believe they are very clever persons. Of course a great many try who do not succeed, but the successful ones are usually able men. I may mention the case of a young man, whose name has been in the papers lately, Mr. Hopkinson, our senior wrangler. He went into both examinations, both the scientific, and the general examination which includes mathematics, and he got a scholarship by both. In fact, we had to elect whether we would take him for his superiority in classics and mathematics, or for his superiority in the non-mathematical sciences, and we gave him an ordinary scholarship, in order to make room for another man whom we considered nearly as good in the sciences mentioned.

5028. (*Chairman.*) One fellowship has already been given to one of the University professors, has it not?—Yes, one was given at the last election to Professor Challis. We had a great number of fellowships to dispose of, and our statutes enabling us to give fellowships to professors, we considered that Professor Challis had the strongest claim upon us. He held the worst endowed of the mathematical professorships, and had served the university the longest time.

5029. Are there any other points upon which you are prepared to give the Commission your opinion?—I have mentioned those which seem to me the most important.

The witness withdrew.

The Reverend COURTTS TROTTER, M.A., examined.

5030. (*Chairman.*) I believe you are a fellow of Trinity College?—Yes.

5031. You are also assistant tutor and lecturer in natural science?—Yes.

5032. And you are the first person, are you not, who has held this latter appointment?—There was a lecturer in natural science appointed temporarily for two years, but he was not a fellow of the college.

5033. What was the special view of the college in establishing that lectureship?—I suppose it was to

supply to a certain extent the demand which was growing up in Cambridge for the teaching of natural science. New science examinations were instituted, and it was thought desirable that the colleges should have some increased teaching power.

5034. Was that with a view to the natural science tripos?—Partly to that and partly to the special examinations for the ordinary degree.

5035. Are your lectures open to all men in the college, whether they are freshmen, or second-year, or third-

Rev. W. H. Thompson,  
D.D.

9 Feb. 1871.

Rev. C. Trotter, M.A.



*Rev. C.  
Trotter, M.A.*  
9 Feb. 1871.

year men?—Yes, but freshmen would, generally speaking, be occupied with other studies, and would not generally come to me. Possibly a candidate for the natural sciences tripos might come in his freshman year, but I have not had any yet. The candidates for the special examinations come in their last year.

5036. That is for the special examinations for the ordinary degree?—Yes.

5037. Do many men who intend to go out in honours attend your lectures?—Yes. I have not had large classes, but the honour class has been the largest.

5038. The number who go out in the natural science tripos is still small, is it not?—Yes.

5039. Has your college taken any steps in other directions with a view to encourage scientific education?—It has appointed, in accordance with the provisions of the new statutes, Dr. Michael Foster as prælector in physiology, and it has also provided apparatus, the University lending a room at present. These arrangements are provisional.

5040. Are the results of the establishment of that prælectorship satisfactory as far as a judgment can be yet formed of them?—Yes. Dr. Michael Foster had a large, and, as I think, an enthusiastic class last term, but he has only just begun his work.

5041. Certain steps have also been taken by the University, have there not, in furtherance of scientific education?—Yes, a good deal has been done in improving the museums, and the laboratories.

5042. Have not new professors been appointed of late years?—Yes, I think the only new natural science professor actually appointed is the professor of comparative anatomy.

5043. Are you prepared to favour us with any views which you may have formed as to the best means of encouraging scientific education and the progress of science in the Universities?—I think that one great thing would be to provide in some way a certain number of posts in which men who were devoting themselves to scientific pursuits could live, and have some chance eventually of being in a position to marry.

5044. Can you explain more definitely what would be the nature of those posts?—They might either be distinctly University posts, additional professorships and assistant professorships, or University lectureships, or they might be appointed by the colleges. I think that the simple abolition of the restriction of celibacy on certain college lectureships would be a great step in that direction. At present a young man who wishes to do work of a scientific kind at Cambridge, and undertakes teaching either scientific or literary, knows that unless he takes orders and intends eventually to fill a college living, every year he spends in Cambridge makes it less easy for him to find any post in which he can finally settle, so that he has to be constantly looking out for an opportunity of getting away from Cambridge, and it is not worth his while to devote himself to any special branch of study with a view to what he expects to be teaching some years hence, when he knows that he very likely may have then left Cambridge.

5045. Does that act as an obstacle to Cambridge doing more for the advancement of science?—I think it does. There is too much energy wasted in what I may call hand-to-mouth teaching, simply preparation for examinations.

5046. Are you able to give the Commission any view you may have formed as to the number of those posts which you would think it desirable should be established. Do you think that they ought to be considerable in number?—Yes. I think that any person really competent to do work of that kind should feel that he had at any rate a very reasonable chance of attaining such a post in due time. I should not like to see the number very definite, because the number of men competent to fill such posts will vary to a certain extent. I think that many of the professors or assistant professors should not be restricted too definitely to particular branches of study.

5047. How would you provide the funds for endowing those posts. Would you appropriate any

portion of the present fellowship fund?—I think that something might be done in that way.

5048. Has not Trinity at present the power in certain instances of dispensing with the condition of taking orders?—Yes, all tutors and assistant tutors, and one or two other college officers—bursars for instance, are not required to take orders.

5049. But what you suggest would not come within the limits of the liberty that the college possesses?—There is no means of dispensing with the condition of celibacy. The University professors are exempt from it, and one or two other University officers, and the prælectors under the new statutes; but there is no power of dispensing with it in the case of college lecturers, or any person but one holding one of the above-mentioned posts.

5050. Do you think that the study of science might be promoted by any other means than that to which you have just referred?—An important want is that of better laboratories and appliances of that kind, and of more assistants in the museums.

5051. Do you mean that additional laboratories are desirable, or that the existing ones are insufficiently supplied?—The chemical laboratory, for instance, certainly wants considerable additions both to the buildings and to its appliances.

5052. Some of the colleges have private laboratories of their own, have they not?—Yes.

5053. Should you like to see that system increased, or would you rather see the University laboratories well furnished?—I would rather on the whole see the University laboratories well furnished. Laboratories may be required at some colleges, but I think that the multiplication of small and ill-appointed establishments of that kind is a mistake.

5054. The University, as a University, is not rich, I believe?—No.

5055. Do you think that further funds are urgently required for University purposes?—Yes, I think they are.

5056. Have you any definite views as to how those funds might be provided?—I think that the best scheme for providing at any rate a certain amount of funds, would be to allow the colleges to tax themselves, that is to say, to allow some body representing the colleges to tax the whole of the colleges. The majority should bind the minority, and the majority of the colleges, or a certain majority of the votes in some body representing the colleges, should have the power of taxing to a certain extent the distributable incomes of the colleges.

5057. Trinity has already expressed its willingness to adopt a system of that kind, has it not?—Yes. The proposition which they actually agreed to was a proposition to pay a fixed per-centage to the University.

5058. Is there still a very strong objection on the part of any of the colleges to a per-centage taxation?—I think that there is a very strong feeling in favour of it on the part of a good many, but I can hardly say what the feelings of the majority would be.

5059. Do you think that the feeling in favour of a proposal of that kind is gaining ground?—I should think it was.

5060. Have you any expectation that it will be brought about without any external interference?—I suppose that an Act of Parliament would be necessary to establish such a body; but I think it is quite possible that it might be done with the concurrence of the majority of the fellows of colleges.

5061. Do you think it is possible that the majority of the colleges might now be disposed to adopt it?—I think it is possible that they might now, or before very long, but I cannot say. I do not know much of the feelings of the colleges outside Trinity.

5062. At present each college has the power, has it not, if it is so disposed, of contributing its five per cent. of its income for University purposes?—There is a provision introduced into the statutes of Trinity by which the college is bound to contribute five per cent. to University purposes, when such provision shall have been introduced into the statutes of all the



other colleges; and in the meantime there is power to grant any sum that they may think proper, and such a provision was inserted, I believe, in the statutes of one or two other colleges, but not of most of them. I do not think that the colleges would be able to bind their successors in any way. I presume that they might grant any sum, year by year, that they thought fit, but they could not make any permanent arrangement; that would depend upon the statutes of the various colleges.

5063. You have had great experience in examinations, have you not?—I have examined several times.

5064. What opinion have you formed as to their value as producing men likely to do scientific work?—I very much doubt whether by mere examination, particularly by a competitive examination, you can find out who is likely to do really good work. It seems to me to test a man's reading and clearness of head; but in science it is not easy to test his original power, or to find out whether he is likely to be an efficient teacher. I would say that I think it extremely difficult in anything like a science examination to introduce real problems. Anything that is more than a mere example is, generally speaking, too difficult and too complicated to be worked out *ex tempore* in the examination room.

5065. Have you ever thought of any alternative that could in any way supersede the examination system?—I should like to see more posts obtainable by work done after a man has taken his degree; if, for instance, he has been a successful teacher in a subordinate post, and particularly if he has done any original work. I should be glad to see, in the fellowship examinations, for instance, a provision that the candidate should be encouraged to send in to the examiners any scientific paper, that he may have published, or, if he likes, work that he may have done in manuscript, in short, some specimen of his power as an investigator and as a student of science in the higher sense.

5066. But you do not see your way to doing away with examinations as the main avenue to fellowships and other posts of honour?—No, I do not see how you can do that; but I think it is a pity to depend upon the examination altogether; but I would say that a special examination for fellowships, where the best one or two men out of a small number have to be selected, is better than a large examination in which a number of men have to be arranged in order of merit. That leads, I think, sometimes to very inaccurate results, because you must be bound then by a definite system of marks, which very often do not represent what the examiner can see of a man's real power.

5067. In the greater part of the smaller colleges at Cambridge I believe the fellowships are given without any examination?—They are generally, in fact almost exclusively, given, according to the result of the great University examinations—the tripos examinations.

5068. (Sir J. P. Kay-Shuttleworth.) I believe that your professorship is connected with the instruction chiefly in heat or electricity?—Yes, that has been the chief subject of my lectures.

5069. Have you laboratories and apparatus prepared for you to enable you to give full illustration of your lectures?—No; most of the apparatus that I have got is my own. The college has fitted up a lecture room for me, with gas and water, &c., and has given a grant for apparatus, and I have also got a good deal of apparatus of my own. I am not able to illustrate my lectures as fully as I should like, but still I am able to show a good many illustrations of the points which are theoretically most important.

5070. Regarding such a professorship as having relation to the entire University, you would desire very considerable improvement in the laboratory and apparatus which should be connected with it?—Yes, certainly. It is proposed now to appoint a professor of experimental physics, and through the munificence of our Chancellor we are to have a physical laboratory which I hope will supply the want.

5071. Have funds been appropriated for the purpose of creating that laboratory for the professor of experi-

mental physics?—Yes; our chancellor has promised to build a laboratory on condition that we appoint a professor, and I hope that the establishment of the professorship is being carried unanimously to-day.

5072. Have you at present the aid of any demonstrator or other assistants?—No.

5073. Is there therefore much individual instruction in the laboratories to the students?—No, we have nothing that I could call a students' physical laboratory at present.

5074. Would you think such an arrangement desirable?—Most desirable; but what we require is on too large a scale to be provided otherwise than by the University, or by some body of that kind with considerable funds at its disposal.

5075. In connexion with the professorship of experimental physics, some such appointments as demonstrators and assistants to the professor would be desirable?—Yes, certainly.

5076. Are those amongst the number of posts, with educational duty of not a very laborious kind, to which you refer as incentives to the study of science in the University?—Yes, it would be necessary to have more than one such post. A single demonstrator would, I hope, have too much work upon his hands to have much time for original research.

5077. You would propose that there should be more than one demonstrator?—I think that if we ever become a school of physics, more than one demonstrator or sub-professor, or something of that kind, will be required, but at present, of course, the whole school has to be created.

5078. (Professor Smith.) Do I rightly understand that yourself and the praelector, Dr. Michael Foster, are the only two persons in Trinity College upon whom the physical science teaching in the college depends?—Yes.

5079. Dr. Michael Foster has the care of the biological department, has he not?—He teaches pure physiology.

5080. On the other hand you have taken the two subjects of heat and electricity?—Yes.

5081. So that there is not any complete course of physical instruction provided within the college?—Not in Trinity; but I should say that we have joined with some other colleges, admitting their students to our lectures and sending ours to theirs. So that, for instance, St. John's gives instruction in chemistry and geology, and we have lately joined with Sidney College, in which a gentleman is now beginning to lecture on botany.

5082. What is about the number of students in the college who attend the lectures on the natural sciences; is it any considerable proportion of the whole number of undergraduates?—Not very large in Trinity. We have very few at present.

5083. Are those chiefly pass men or men reading for honours?—My largest classes I think (although they have all been very small) have been of honours men.

5084. Do you find that the men who come to the experimental study of heat and electricity are chiefly men who are fair mathematicians?—Not for the most part. The mathematical treatment of the subjects is not introduced into the natural sciences tripos, but a change has been made in the mathematical tripos which will allow of the introduction of those subjects into that tripos, and I am proposing to give this term a short course of experimental lectures and demonstrations mainly for the mathematical men, for those who wish to answer questions in the physical subjects in the mathematical tripos.

5085. But as yet that is an experiment?—Yes, I have only given one lecture yet.

5086. You spoke of the staff of the University chemistry laboratory as being at present insufficient. Will you be kind enough to state what the staff is at present?—At present the staff consists only of the professor and an assistant for manual work.

5087. I understand that there is no demonstrator whatever?—There is a grace before the senate to-day

Rev. C.  
Trotter, M.A.  
9 Feb. 1871.



Rev. C.  
Trotter, M.A.

9 Feb. 1871.

for the appointment of a demonstrator which I hope will be carried, but up to this time there has not been one.

5088. Could you state what is about the number of students in the University in the chemical laboratory?—I think that we have room for something like 36 students, and it has been at times nearly full, if not quite; it has varied a great deal according to the time.

5089. In your opinion, is not that number quite too large to be taught by a professor alone without the assistance of a demonstrator?—Yes; I think that to the men who are working in practical chemistry it is very important that they should have some one almost always at hand to whom they can apply in difficulties, not that each one would require very much individual teaching, but there ought to be some one of this sort who was willing to be interrupted, and who could help them.

5090. (*Chairman.*) Are the lectures which you give to the honours men different from those for the pass men?—Yes; I am giving three sets of lectures this term, a set for the pass men, a set for the natural sciences tripos, and a set for the mathematical tripos.

5091. Does the new system of the mathematical tripos come into operation next year?—It comes into operation in the beginning of 1873, so that the men who are to be entered for it for the first time are now in their second year.

5092. Does it attract much attention amongst the young men? Do you think that a good many are preparing themselves for that branch of the mathematical tripos?—I should think it did. I had about 12 at my lecture yesterday, and I hear that Mr. Stuart, who is lecturing on the theoretical part, had a considerably larger number than that at his first lecture.

5093. Are those all Trinity men?—No; those are partly from other colleges.

5094. In the mathematical tripos henceforward heat and electricity are to be treated mathematically, are they not?—Yes.

5095. But in the natural science tripos no mathematics are introduced?—High mathematics are positively excluded. There are no difficult mathematics, but I should say that the want of mathematical preparation on the part of men who are candidates for the natural sciences tripos in physics makes the subject a very difficult one for them, and one which is consequently not very satisfactorily treated. I have examined for the last two years in physics, and I think that the result was inferior to what it was in most of the other subjects for the natural sciences tripos.

The witness withdrew.

Adjourned to to-morrow at half-past 11 o'clock.

No. 6, Old Palace Yard, Westminster, Friday, 10th February 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
GEORGE GABRIEL STOKES, Esq., LL.D., Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

The Rev. HENRY WILKINSON COOKSON, D.D., examined.

Rev.  
H. W. Cookson,  
D.D.

10 Feb. 1871.

5102. (*Chairman.*) You are master of St. Peter's College, Cambridge?—I am.

5103. And were formerly tutor of the college?—Yes.

5104. You are now chairman of the board of natural science studies?—Yes.

5105. And also member of the local examination syndicate?—Yes.

5106. You have several times held the office of vice-chancellor, and have given much time and atten-

5096. Are the candidates that go in for that tripos generally very indifferent mathematicians?—I should think that a large proportion of them were; but candidates who have passed in the mathematical tripos are allowed to be candidates a year later in the natural sciences tripos, and there were three or four last year in that position.

5097. Do you find a marked superiority amongst them over those who go in merely for the natural science?—I should say so, but it so happened that most of the men of whom I am speaking devoted their chief attention to other subjects than physics.

5098. Are there any other points which you have considered, especially with reference to the advancement of science, and instruction in science, on which you could furnish the Commission with the result of your consideration?—I do not know that I have anything to say further than what I have already offered to the Commission; I should say that I think science is likely on the whole to be most furthered by those who have got some educational work to do.

5099. Do you think that many of those young men study science with a view to get educational posts in the country in public schools or elsewhere?—No doubt some do; but the number of candidates has been on the whole so small that I do not think any very great number have done so with that intention, and I should say that a large proportion of the candidates for honours in the natural science tripos have always been medical students.

5100. Do you attribute the smallness of the number to the novelty of this tripos, or are there any other causes to which you consider it to be due?—I think that it is due partly to the novelty, and to the fact that there is not much reward for it in the University.

5101. Would not any man who had distinguished himself greatly in the natural science tripos be pretty sure of obtaining a fellowship?—I think that anybody who was known to be distinguished in science probably would; but, as I say, it is very difficult by any examination (particularly by an examination like the natural science tripos, in which the result is the aggregate result of a number of examinations in natural science subjects,) to show that a man has really distinguished himself in science. I do not mean to say that many good men have not gone out in the natural sciences tripos, but I do not think that a high place in the natural sciences tripos is of itself a proof that a man is very able, or that he is on a par with a man who takes the highest honours in other subjects.

tion to the affairs of the University?—I have. I have been three times vice-chancellor.

5107. The University has, I believe, done much of late years to encourage the study of natural science and physics?—It has.

5108. Will you explain the different measures that have been adopted by the University in that direction?—I may premise that for a great number of years mathematics and natural philosophy, including mechanics, hydrostatics, optics, plain and physical astro-



onomy, and the doctrine of heat, light, and sound, had formed the principal subjects of study in the University. The subjects of natural science, such as chemistry, geology, botany, mineralogy, and also the application of mechanism, had been lectured upon in the University, but they had not until about the year 1848 formed any part of the University curriculum; but about the year 1848 the University established the natural sciences tripos—an examination for honours in natural science, and in 1865 it established special examinations in natural science for the ordinary degree. About the same time it expended a sum of about 30,000*l.* in the erection of museums and lecture rooms in connexion with natural science, and it now devotes 2,500*l.* a year as a building fund and a maintenance fund; 1,000*l.* building and 1,500*l.* maintenance. I believe that the museums and lecture rooms thus erected are found to be efficient; they require extension, but as far as they go I am told they are very good. The collections in them, I believe, are also good, though in some instances small. The geological museum has a high reputation, and for the purposes of academical instruction is perhaps unsurpassed by any museum in the kingdom. The collection is well selected and well arranged, and is for the most part named and in some respects catalogued, and the work of cataloguing is going on. It is so rich as to be frequently consulted by eminent palæontologists both in this country and abroad. The mineralogical museum, with its working rooms for the professor, the lecture room, and the student laboratory is all that can be wished, and the collection has been arranged and named by Professor Miller himself. It is unnecessary to go into particulars, perhaps, with regard to all the other museums, but I might almost say the same of the museums of botany, of comparative anatomy, of zoology, and perhaps also of the museum of human anatomy. They are good, I have been told, but they require extension, as they are but small, and I believe there is not a department in which a good beginning has not been made. In 1866 the University established a professorship of zoology, and about the same time made the professorship of anatomy permanent, and appointed a demonstrator of anatomy. In 1869 the Senate made considerable changes in the regulations for the mathematical tripos so as to give greater prominence to the study of heat, electricity, and magnetism, and to assign more weight generally to physical subjects in the examination. So lately as yesterday, I am happy to say, the Senate established a professorship of experimental physics, and, through the munificence of our chancellor, this department is likely to be soon provided with a building containing a laboratory, a lecture room, and proper apparatus; and also they yesterday increased the stipend of the professor of chemistry from 300*l.* per annum to 500*l.* per annum, and they established a demonstrator of chemistry, and those measures were passed without a dissentient voice. These steps indicate that the University desires to give encouragement to physical science and to improve its means of instruction, and it would doubtless have done more if its pecuniary resources would have allowed it.

5109. Can you point out any sources from which additional funds could be obtained?—I think that the best plan of obtaining additional funds for the University is by means of a charge upon the corporate revenues of the colleges. I do not consider a contribution from the funds of the colleges inconsistent with the main objects of the foundations. The founders were desirous that those who resorted to the University should be instructed in all the different branches of human learning, and the colleges may in some subjects provide excellent instruction within their own walls, but obviously far better instruction could be provided in other cases by means of public teaching in the University by a system which would virtually be inter-collegiate. In many departments the teachers require a good museum, apparatus, drawings, and books, and these are much better provided by the whole University together, and much cheaper,

than they would be by each separate college. This plan was suggested by the University Commissioners in 1856. They proposed that each college should pay to the University chest, to be applied to the purposes of the University, a sum equal to five per cent. upon the distributable income of the colleges. The method was proposed by the Commissioners to the colleges in the form of a statute, but each college had the power, by a vote of two thirds of the governing body, to refuse the acceptance of the statute. The consequence was that four only of the colleges accepted it—St. Peter's, Trinity Hall, Christ's, and Trinity College; 13 other colleges refused it, and, in consequence, the plan has been wholly inoperative. I think that this fund ought to be essentially a trust fund, and might be applied by the University to providing endowment stipends for professors. There is a charge at present upon the University chest of 4,000*l.* per annum, or thereabouts, for the stipends of professors, and if separate endowment stipends were provided by means of contributions from the colleges the chest would be relieved to this extent, and the funds would be available for other objects which the University desires to accomplish, and, amongst them, the promotion of natural and physical science. If a plan like this were adopted I think it would be important to retain the principle of respect for vested interests; no present holder of any college emolument ought to be called upon to contribute an annual per-centage without his consent, but I believe that a great number of persons would waive their claim to exemption. I have stated that in 1856 this plan was not carried out. In May 1869 a syndicate was appointed by the University to consider the question of raising funds, and the above-mentioned plan was suggested as one method of doing so. The syndicate applied to the colleges to ascertain whether they were willing to contribute. Several gave answers more or less favourable; but on the whole there was not sufficient agreement to enable the syndicate to report in favour of this or any other plan of raising a large income. The syndicate pointed out to the colleges that they might severally obtain the necessary powers from the Queen in Council by means of college statutes, or that they might unite in applying for an Act of Parliament. The question has, I believe, made favourable progress in the University since that time, but no further step has been taken in the matter. I think the above mode of raising funds for the encouragement of scientific teaching and other important objects preferable to that of suppressing fellowships. I do not consider the fellowships too numerous. I think more of them might be held by professors. The colleges have already elected some of the professors to fellowships, and I certainly think that they might elect more. I also think that it would be much better to have a fixed charge, say, of five per cent., the amount recommended by the Commissioners, upon all incomes than any plan of taxing the incomes by a board of representatives of the several colleges, for that method would involve continued controversy and debate about matters of money, and I think that it is highly desirable to avoid such. I also think it is undesirable that any professorship should be attached to a particular college. The case is one in which the collegiate element would, I think, act injuriously. The professors ought to be the best men that can be obtained, and the University ought to be quite free in its choice of them. I think it is highly desirable that both the Universities and the schools throughout the country should do a great deal more than they do in the way of teaching and cultivating natural and physical science, and I think it is especially necessary with regard to schools. Candidates would then come to the Universities better prepared, and some of them might study the subjects there with such success as to be placed on a par with the best classical scholars or the best mathematicians in competing for fellowships or other prizes. An indirect consequence also would be that there would be more demand for qualified teachers, and masterships and other situations would

Rev.  
H. W. Cookson,  
D.D.

10 Feb. 1871.



Rev.  
H. W. Cookson,  
D.D.  
10 Feb. 1871.

be open to graduates who had made some branch of natural or physical science their chief study. I do not consider the University of Cambridge a good place for a school of mechanical engineering. The general principles of machines and mechanism may be studied there or in any other University, but their practical application would be better learnt at the great centres of mechanical industry, where the student would have examples of mechanical operations daily before his eyes, and could become acquainted with the practical difficulties with which engineers and artisans have to contend. I think that schools of science of this kind might with advantage be established in all the great centres of mechanical industry, such as Manchester, Leeds, Birmingham, and elsewhere, and I consider that absolutely necessary if this country is to hold its place among the nations of the world.

5110. How far do you consider the results of the natural science tripos satisfactory?—I do not think that at the present time there is any great number of students who have attained to a great degree of eminence in the different branches which they have taken up. I have heard the opinion expressed by the examiners at the Board of Natural Sciences that the candidates have been inferior, and sometimes they have a difficulty in making a first class.

5111. Do you think that there is more difficulty in conducting an examination in the natural sciences than there is in classics and mathematics? Do you think that they are less suitable subjects for examination papers?—No, I do not.

5112. The alterations in the mathematical tripos to which you have referred have not yet come into operation, I believe?—No.

5113. And several of the same branches of science form part of the mathematical tripos and also of the natural science tripos, but in one they are treated mathematically and in the other experimentally?—They consider in the natural sciences tripos that mathematics are to a great extent excluded, and they treat them more mathematically in the mathematical tripos.

5114. Are heat and electricity included in the natural science tripos?—They are.

5115. And, also, in the mathematical tripos they will, under the new regulations, to a great extent be included?—Yes.

5116. But treated of course more mathematically?—Not entirely. It was intended that they should not be treated entirely mathematically. By that I mean that there are certain questions that would not require a knowledge of mathematics to answer.

5117. What has been the result of including natural science as one of the subjects for obtaining the ordinary pass degree?—A young man who had a taste for natural science might select that subject for his final examination, and it was an encouragement to diligence to allow him to take that instead of taking a subject which he had no taste for.

5118. Do any considerable number select one of the natural sciences as the means of obtaining a pass degree?—No, the numbers are small at present.

5119. You stated that you think that the proposed plan for raising funds for University purposes by a percentage on the college revenues is making progress. Do you consider that there is a probability of the result being obtained without any external interference?—I am not prepared to say that. I should like to see a renewed effort to get the colleges to consent, because I believe that the colleges, by means of statutes, would do it better than it would be done by means of a simple Act of Parliament. I am unable to say whether there is any such probability as that indicated by your question.

5120. Can you indicate at all the general nature of the objections? Is it merely to parting with so much of the revenues of the college?—I cannot tell, for in my own college when I heard it discussed the proposal was accepted without a dissentient voice; in others it was rejected without a dissentient voice.

5121. In your allusion to the plan of having a representative board for taxing the colleges, do you refer to a plan which originated at Caius College?—That amongst others.

5122. That plan has been communicated to the Commission in a separate paper; but there have been other plans, have there not, of the same nature?—Yes, of the same nature; not perhaps matured, but we have heard of others of the same kind.

5123. A certain number of fellowships have been given, have they not, during recent years, to persons who have distinguished themselves in natural science?—Yes. I omitted that part of my evidence. I wish that there had been candidates to have enabled the colleges to give more of them, and the same with regard to scholarships. I believe that the colleges are quite ready to elect into fellowships persons who have distinguished themselves in natural science, as much as if they had distinguished themselves in mathematics. I believe that the colleges would be ready to receive them with open arms, but it does not seem to be fair to give the preference and to elect an inferior man who has been studying natural science, when there is a person who has been devoting all his life to classics or to mathematics, and who has distinguished himself in those subjects. It is the same with regard to scholarships. Candidates for scholarships come up well prepared in mathematics and classics, and pass very good examinations in them. Candidates come up for natural science who do not pass such good examinations; and in consequence there is no encouragement to open the scholarships to candidates in natural science as compared with mathematics or classics.

5124. You have stated that you would be glad to see professors frequently elected into fellowships. I do not understand that you would wish any fellowships to be permanently attached to a professorship?—No, certainly not.

5125. But you would like to see the colleges themselves voluntarily adopt the system of electing eminent professors?—Yes; professors who have been successful in getting classes, or who have taken great pains, or who from particular circumstances might seem to require an addition to their stipend.

5126. That has been done, we are aware, in one instance, in the case of Professor Challis. Have there been other instances of the kind?—I believe Professor Stokes is an eminent instance of it, and Professor Fawcett, of Trinity Hall, and Professor Wright, who was elected a professor the other day, was elected a fellow of Queen's.

5127. With reference to the schools that you would like to see set on foot in the great centres of mechanical industry, would you contemplate that the instruction given in those schools should be both scientific and practical?—Certainly.

5128. You would not make it simply of a practical character?—Certainly not.

5129. You would require as indispensable sound scientific instruction?—Certainly. I think that we might often get young men there from the Universities who had had a good theoretical education, who would in a short time become excellent teachers in the practical work as well.

5130. Do you consider one reason of the comparatively small number who devote themselves to natural science to be that young men do not see any great prospect of its furnishing them with a career?—Certainly.

5131. But the introduction to a greater extent of natural science in the schools would in some degree operate to counteract that feeling?—Yes, certainly. We find that now in classics and mathematics a great many young men of talents become teachers in the schools and go off, and are glad to go off immediately; and if natural science were taught in the schools they would go in like manner to teach natural science.

5132. Several of the more important schools have made considerable advances, have they not, in that direction?—Yes.



5133. And steps are still being taken?—I have understood so.

5134. (*Sir J. Lubbock.*) I presume the introduction of natural science in the schools would also act upon the University. You would then have students coming up to the University who would be better prepared in those subjects, and therefore more likely to compete with your other students?—Yes, I have said so.

5134. You stated just now, did you not, that it was unfair to give fellowships to natural science if there were men better qualified in classics or mathematics?—Yes, if there were a higher standard. Of course, if the mathematicians or the classical scholars were much more distinguished in their particular department than the candidates in natural science were, we should prefer giving fellowships to the mathematicians or to the classical men.

5135. Do not you think it is very difficult to compare acquirements in such different branches of learning?—It is difficult, but I do not think it is impossible.

5137. As long as the great majority of University rewards are attached to mathematics and classics, I suppose it would follow almost as a natural consequence that you would have comparatively few men of great acquirements in other branches. You would have a smaller body to select from?—Yes; but there is no reason why you should not have good candidates in natural science, and if there were good candidates in natural science the colleges would be only too glad to receive them.

5138. But so long as there are so very few rewards for natural science, naturally the most able men are tempted or bribed, if one may say so, to take up those studies which are most amply rewarded, both in respect of University rewards and also of rewards in after life?—Yes, I suppose it would be so.

5139. Therefore, assuming the great importance of natural science, surely the course to adopt is to attach a proportionate amount of rewards to acquirements in natural science, and then trust to the natural course of things, that you would have students equally well prepared in the one subject as in the other?—If you attach rewards at all to them. We say, here are fellowships vacant; we want to elect distinguished men into them; you have no distinguished men in natural science; you have distinguished men in classics and mathematics, and you select accordingly.

5140. But, surely as long as you continue the old system you never will have many eminent men in natural science, for you do not give natural science a chance, and yet you say that there are no eminent men in it; surely the course to adopt would be to treat the subjects in fairness as between the one and the other; and then if you found, after a while, that you did not have eminent men, I admit that there would be a case for a change; but if natural science has not yet had fair play you can hardly judge in the matter, can you?—We only consider ourselves acting in trust to bestow the rewards upon the most deserving; and if we cannot find deserving candidates amongst the students in natural science we must go elsewhere, and we give every opportunity to those students in natural science to prepare themselves. The University is as much open to students in natural science as it is to students in mathematics.

5141. But is it not also one of the functions of a great University to direct the higher education of the country?—You cannot compel persons to come and study natural science.

5142. Certainly not; but have you as yet, do you think, given to natural science the same amount of encouragement as you give to the study of other branches of human knowledge?—I think that as far as the University and the colleges are concerned we have done so; everything is perfectly open. We give them the means of instruction and then invite them to come; but they will not come—they have not been prepared at school.

5143. They do not prepare them at school because

there are not the same number of rewards in the Universities, so that the Universities do not reward them because they are not taught in the schools, and the schools do not teach them because they are not rewarded in the Universities. Is it not necessary that we should in a manner change the system altogether; is not the one naturally dependent to so very great an extent upon the other, that either to change the system in the schools without altering the system in the Universities, or the system in the Universities without altering the system in the schools, must necessarily lead to an unsatisfactory result, and do not you think that the alteration in the two ought to go *pari passu* with reference to one another?—I think that more depends upon what a man can do in after life, whether he takes up natural science, or whether he takes up mathematics or law or anything else. There is very little encouragement in after life to a student in natural science. I think it would be considerably different if natural science was more cultivated in the schools.

5144. At present take the case of Eton, where there are 40 classical masters and one natural science master; no doubt taking that school, which after all is perhaps rather a favourable one for natural science, there are 40 rewards for classical attainments to one for scientific attainments; but if you have an alteration of the system in the schools generally throughout the country, then there would be as great an opening for a man in after life in natural science as in classics, would there not? If we except the posts that are open in the schools and in the Universities, there is not otherwise in this country a greater career open to those who know classics than to those who know chemistry, but rather, if anything, the reverse; that is to say, there are a great number of places open in chemical works throughout the country which have nothing corresponding to them, I think, in the case of classics?—I do not see that the Universities can do more; they open their fellowships and scholarships to all candidates, and they give the means of instruction in all subjects alike. It is for the candidates to select what subjects they like to take up. I do not see that it is within the power of the University to make any change in the matter, for it throws open all its fellowships and scholarships alike to students of every description, and affords the instruction which it does.

5145. Assuming that the schools altered their system, do you not think that throwing those fellowships and rewards of different kinds open in the University would have a much greater effect than it has had hitherto when the schools have been practically closed to natural science?—Yes, I think so.

5146. The course pursued by the public schools has been one great reason, has it not, for the little effect which has as yet been produced by what has been done by the Universities?—Yes, it has.

5147. (*Professor Stokes.*) Are you of opinion that students generally are aware that they are as likely to obtain a fellowship for high distinction in (we will say) natural science as for high distinction in classics or mathematics?—I am afraid not in the country generally.

5148. But they are in the University, are they not?—I think it is perhaps imperfectly known in the University.

5149. You said that you did not think that there were too many fellowships at present in the University; are you of opinion that the system of free tenure by non-resident fellows, or a tenure at least limited only by the condition of celibacy, is a good one?—It is a difficult question, and I am not able to express an opinion upon it.

5150. (*Professor Smith.*) With reference to your statement that you do not think the fellowships too numerous, could you mention roughly what is the average number that are filled up annually in the University of Cambridge?—I am unable to state that.

5151. You would think the number too large, would you not, for the educational purposes of the University; that is to say, for providing teaching power

Rev.  
H. W. Coleson,  
D.D.

10 Feb. 1871.



Rev.  
H. W. Cookson,  
D.D.  
10 Feb. 1871.

within the University?—Unless you had a great number of fellows you would not have teachers to select from; that would be my view of it.

5152. And you think that it is expedient to have a large number of fellows with a view to selecting a number of excellent teachers?—I think so. Without a large number of fellowships, we should not have so many young men of talent resorting to the University.

5153. Is any part of the examination in the natural sciences tripos practical?—I am not certain with regard to that.

5154. With reference to the place of physics in the examination for the natural science triposes—that is to say, the subject of heat, light, and electricity—you spoke of mathematics being excluded; is that exclusion total?—No. I meant the mathematical investigations of the laws of heat and electricity.

5155. You meant that what are technically called the mathematical theories are excluded?—Yes.

5156. You spoke of the candidates for scholarships in natural science being not of a very high standard of attainment; do you notice an improvement in that respect or not?—I have not had a great deal of experience in the matter; but as far as my experience goes I should certainly say that the standard has not improved, and I feel discouraged in throwing open the scholarships to natural science from the difficulties found in getting good candidates.

5157. Are the subjects of examination in the natural science scholarships generally all the various subjects of physics, and chemistry, and biology?—They are different in different colleges. I think in all chemistry is selected; in some there is a choice of botany, geology, anatomy, or physiology, and they may choose either one or two of those subjects.

5158. (*Sir J. P. Kay-Shuttleworth.*) Did I rightly understand you to say that out of the University chest 4,000*l.* annually is devoted to the establishment of University professorships?—About 4,000*l.* is expended in the payment of the stipends of the professors.

5159. Would you enumerate what those professorships are?—Law, history, chemistry, anatomy, botany, the Jacksonian professorship—that is mechanism and experimental science—mineralogy, political economy, music, zoology, moral philosophy, Sanscrit, and now experimental physics, making the sum of 3,941*l.* There are some other items, but I should put it at about 4,000*l.*

5160. Of those I find that seven are professorships of natural science, and six are professorships of art, or literature, or political philosophy?—Yes, quite so.

5161. The proposal to take five per cent. from the incomes of the several colleges which were estimated I believe by the Commission at 180,000*l.* per annum, would at that estimate produce about 9,000*l.* per annum?—Yes.

5162. Therefore there would remain, if the University chest were relieved of this 4,000*l.* per annum, 5,000*l.* to appropriate to new professorships of all kinds?—Yes, and to the increase of the stipends of the old professors.

5163. You would not, I apprehend, confine the new professorships which would be established by that fund to professorships of natural science?—No.

5164. They would probably bear a similar proportion to that now existing in relation to the professorships of other subjects?—I would not say that quite; the English language would be one subject, and an increase to the professorship of Latin would be one, and there would be one or two others.

5165. There would be certain professorships of art and literature, and probably of moral and political philosophy, besides the professorships of natural science?—I think that that would be best left entirely to the discretion of the University; they would know what their wants were.

5166. My object is to ascertain by those questions what would be the additional amount appropriated upon that scheme towards the teaching of natural science by the University professoriate; if seven

thirteenthths of the 4,000*l.* are at present appropriated to the teaching of natural science, would the probable proportion of the 9,000*l.* to be derived from a tax on the revenues of the colleges, be similar?—I cannot say. I think if you wish to arrive at that conclusion it might be better to look at the several professorships of natural science and see what additions would be made to them; but there are some other professorships which are not included in the list which I have given you, and which are still professorships of physical science, which ought to be increased also. For instance, the Lowndean professorship of astronomy, I have no doubt would be increased as well; that is an endowed professorship, but the endowment is not adequate.

5167. In the application of the fund which it was proposed to create by this tax of five per cent. upon the revenues of the colleges, I apprehend that the maintenance of the museums was likewise included?—I did not so consider it. I think it is important to make this charge of the colleges go more in the way of an endowment stipend, and the maintenance of the University museums, and the payment of assistants and expenses of that kind, I think would be best borne by the ordinary income of the chest. The capitation tax is one great source of income, and the fees another, which would vary very considerably, and I think it would be better borne from the chest.

5168. Passing from the general consideration of the fund to its special application to the professor, his income first of all would consist, according to your view, of a fixed stipend provided from this fund?—I think if a trust fund were created, the University would manage the particular appropriation of the stipend perhaps from time to time; they might not make it any fixed sum; they might have the power of altering the stipend, but that the money should go for the stipends of the professors.

5169. But although the stipend might vary in amount the University should still define what sum should be given to each professor?—Yes.

5170. Do you contemplate that a professor should have any share of the fees derived from students attending his classes?—Yes.

5171. I think I understood you to say just now that you would pay the demonstrators and assistants of the several classes of experimental physics, and the assistants in the museum, from the University chest?—Yes, from the University chest, certainly.

5172. In connecting a fellowship with any of the different chairs of the central scientific and literary teaching of the University, you would not make that connexion absolute and perpetual, but it should be conferred by the colleges according to their discretion?—Yes.

5173. Would not the attraction of very eminent men to such professorships and to consequent residence within the University be increased in proportion as the average emoluments of their chairs was considerable and certain?—I should think so.

5174. In that case might it not in some instances be desirable that a certain fellowship should be permanently attached to a chair?—I think that each professorship ought to have a separate endowment from the University, as far as possible, and that the colleges might be left still to have the discretion of electing a particular professor into a fellowship. I think that no more than that would be necessary.

5175. Supposing a student to have been prepared in a public or endowed school in any department of natural science, and to come to Cambridge to pursue his studies, what acquirements in mathematics or in classics does the University now require as indispensable to the pursuit of the studies in the college or University?—A slight knowledge of the elementary parts of mathematics, arithmetic, and Euclid, and in classics Latin and Greek, not much of either, but an elementary knowledge of both, one of the four Gospels in Greek, and Paley's *Evidences of Christianity*. There is a question before the University whether modern languages should not be substituted for Greek,



but that is only under the consideration of the University at the present time. If the student wishes to become a candidate for honours, he is required to pass an additional examination in the elementary parts of algebra, trigonometry, and mechanics.

5176. Within what period can the examination to ascertain whether those acquirements have been attained be passed, so as to leave the student free to pursue natural science in the University?—At the end of his second term. There is an alteration in that respect under the operation of the new law. He may now go in in his second term.

5177. After having passed that examination satisfactorily at the end of the second term, is there any impediment now in the University to his passing in honours in natural science and being elected to a fellowship?—None whatever.

5178. So that after having passed that first examination he may enter ultimately, by honours in the natural science tripos, into the government of the University?—Certainly.

5179. Did I rightly understand you to say that the preparation of candidates for scholarships in classics and mathematics is at present in the great majority of instances much more complete than it is in natural science?—Yes, as a general rule.

5180. But also, I understand you to say, that if the candidates were equally well prepared in natural science the colleges would be quite willing to give them admission to scholarships and to fellowships as candidates that were prepared in classics and mathematics?—I cannot speak of all, but I believe that in almost all the colleges they would.

5181. (*Chairman.*) Are you able to state how many fellowships have been given hitherto for eminence in natural science alone?—I am not, and it would be very difficult to state it, because sometimes a candidate in natural science has been eminent in other respects. That was the case with regard to one in my own college. We elected him mainly for his natural science, but he had been distinguished in other respects.

5182. Have not some of the larger colleges on one or two occasions announced their intention of giving fellowships specially for eminence in natural science?

The witness withdrew.

The Rev. HENRY LATHAM, M.A., examined.

5192. (*Chairman.*) You are a fellow, tutor, and prælector, are you not, of Trinity Hall, Cambridge?—I am.

5193. The Commissioners will be much obliged to you if you will furnish them with some information respecting the recent arrangements in Cambridge for providing instruction in natural and experimental science?—I may mention, first of all, that yesterday at a congregation a professorship of experimental philosophy was established, with a salary of 500*l.* a year; that the stipend of the professor of chemistry was raised from 300*l.* a year to 500*l.* a year, and that a demonstrator of chemistry was appointed at a salary of 100*l.* a year, and that the University came into possession of the funds to enable them to make this increase through an arrangement with the colleges by which the colleges relieved the University of certain burdens to the extent of about 1,500*l.* a year. Arrangements for lectures in the natural sciences have been made by the lecturers of Trinity, St. John's, and Sidney Colleges together. The lectures are open to the students of all colleges on the payment of a guinea fee. There are two courses at Trinity College on electricity and magnetism, treated both theoretically and in an illustrative manner; a course on chemistry and instruction in practical chemistry at St. John's College; a course on geology at St. John's College; a course on structural and morphological botany at Sidney College, and a course on physiology by the newly-appointed Trinity prælector in physiology, which is given at the new museums, where there is also a physiological laboratory open for practical instruction. In addition to this there has been a union lately of the lecturers of several

—Yes, certainly. Trinity has, and I think St. John's also, but there they have examination for their fellowships. At the small colleges they have no examinations. They take the University examination, and are therefore free to elect any that distinguish themselves.

5183. The rule at a great number of colleges would be to elect an eminent man in some department of knowledge?—Yes, certainly.

5184. But no special number are attached either to classics or mathematics, or to science?—No; it is a prevailing error to suppose that that is the case.

5185. You stated as one reason why you would like the number of fellowships kept up to its present amount, that it affords an opportunity of selecting persons adapted for teaching. Do not a considerable number of persons obtain fellowships who have no intention of ever taking any part in the University business?—Yes.

5186. Perhaps that is not the case so much in the smaller colleges as in the larger ones?—It is as much almost in the one as in the other; but we should not have the number of distinguished men resorting to us unless there were those rewards for them.

5187. A considerable number of the fellowships may be looked upon, may they not, mainly in the light of prizes?—Yes, they are the prizes which attract eminent men.

5188. And you feel a doubt whether the number of them is larger than is required?—I would rather diminish the average income of all (always respecting present rights) than diminish the number of them.

5189. Do you think that a sufficient number of fellows take part in the University teaching in one shape or another, either as public tutors or as private tutors?—We have a very efficient staff in the University.

5190. Is there any other point upon which you wish to make any addition to your evidence?—None occurs to me at the moment, except that when I mentioned engineering I intended it to apply perhaps to some other subjects.

5191. Would it include such a subject as mining and the superintendence of the mineral industry of the country?—Yes, quite so, and shipbuilding also.

of the colleges for the purpose of establishing courses of lectures on subjects connected with the higher physics and the higher mathematics, especially to embrace those subjects which have been recently introduced into our tripos of mathematics and natural philosophy, namely, the subjects of electricity, magnetism, and heat. A series of lectures has been arranged which includes the application of mathematics to electricity, and magnetism, the dynamical theory of heat, sound, the theory of elastic solids, and the higher branches of mathematics generally.

5194. Those new arrangements for the mathematical tripos are not to come into operation for about two years I believe?—I think in the tripos of 1873. Those who are now freshmen will be examined under the new system, and these preparations have been made for their instruction.

5195. Those arrangements have been made, have they not, by mutual arrangement amongst certain of the colleges?—By an arrangement made at a meeting of the mathematical lecturers of the Colleges generally. In addition to those arrangements there are six colleges which are combined altogether for lectures, and which have established a complete course of lectures in mathematics and one embracing various subjects of natural science, also classical lectures.

5196. Has that system been for some years in operation?—That system has been established now for about three years. It arose out of the new system for the ordinary degree whereby a person was allowed to devote the last year of his course to any one of ten different subjects—theology, law, chemistry, geology,

Rev.  
H. W. Cookson  
D.D.  
10 Feb. 1871

Rev.  
H. Latham,  
M.A.



Rev.  
H. Latham,  
M.A.

10 Feb. 1871.

zoology, botany, modern history, moral philosophy, political economy, and applied science.

5197. The colleges have made arrangements for instruction in those different departments, have they not?—Yes; and as no college could provide instruction in all, it led to combination, and this combination has been carried out also to subjects for mathematical and other honours, and has been found to succeed very well. There are two or three of such combinations. There is a combination between Trinity, Sidney, and St. John's; there is that of six colleges before-named, and there is a third combination; so that the colleges are now in groups for educational purposes.

5198. And the system has thus far answered so successfully that it is likely to be maintained?—Yes, it is spreading generally, and answers very well. Trinity Hall has combined with King's College and with Caius College, but more completely with King's College. We find this such a great assistance, that the amount of private tuition required by the students for the mathematical tripos is materially decreased, and I believe that private tuition in other subjects is diminishing, owing to the greater number of lectures and the smaller classes that can be formed.

5199. So that the tutors are able to give much more attention to their individual pupils?—Yes, much more attention. I believe it to be almost impossible to teach the harder parts of mathematics and natural philosophy properly to a class of more than from six to ten.

5200. Do you think the decline of the system of private tutors desirable?—I should be very sorry that there should not be private tutors, because there will always be persons who will want to be studying subjects upon which they cannot find a suitable lecture when they require it; but I should be glad to see things so arranged that a private tutor should not be essential in ordinary cases simply on the ground of expense. I think that the presence of private tutors in Cambridge is very desirable, as they help to increase the number of persons who are devoting themselves to scientific subjects, and they give freedom to our system. The colleges sometimes provide an able man with a tutor.

5201. Can you give the Commission any information with respect to the natural history clubs at Cambridge?—There are two. There has been for the last 40 years the Ray Club, which contains 12 members, and, I think, seven associates. The 12 members are masters of arts, and the seven associates are undergraduates. This society meets once a week, in the evening, and any member is at liberty to introduce any other person. This club has kept alive a certain taste for natural history and an interest in it in the University.

5202. Do they read papers?—No, I think not; specimens are exhibited, and discussion takes place. A paper may occasionally be read, but there are no formal transactions. There is also a more recent society which has been established about three years, called the Cambridge Field Naturalists Club, which contains 40 members, of whom about 35 are undergraduates, and the professors of zoology and botany are also members. They meet usually once a fortnight in term time, and discuss matters, and exhibit specimens. They make excursions from Cambridge to the neighbouring *habitats*, and botanical expeditions, and expeditions to places of geological interest.

5203. Are you aware whether the professors who are connected with those subjects think favourably of the results of those clubs?—I think they consider them to be desirable as tending to spread an interest in those subjects, particularly amongst the undergraduates.

5204. Are the numbers which you have given fixed, or do they merely happen at present to be the numbers?—The number of the Ray Club is fixed; that of the Field Naturalists' Club is not fixed.

5205. Are you able to state to us how many students took degrees in natural and applied science during last year?—In the natural sciences tripos in last December, 18 persons took their degree; in the special examinations for the ordinary degree 25 passed in natural science, and 13 in the applied sciences in 1870; so

that on the whole in the two branches of natural and applied sciences there were 18 in honours, and 38 passmen, that is one-ninth of the graduates of the year.

5206. Is any considerable amount of proficiency in those branches required from those who take the ordinary degree?—Yes, a very fair amount. Pupils of mine have passed, particularly in the applied sciences, and I have seen something of what they know, and the knowledge was creditable and useful. They generally took considerable interest in their work. I consider that the system of allowing students to choose their own subject, and give their last year to it, has worked very well; they certainly take far more interest in the subjects which they choose for themselves than they did in the old "poll" course.

5207. Do you think that any go through this examination, or go out in those branches of natural and applied science with a view to their future career in life?—The difficulty connected with the natural science branches has always been that there are so few courses of life in which such knowledge is remunerative. There may be a few men with us who are going into engineering works, and who go out in applied sciences or in natural science, but we have no great number of persons, I think, at Cambridge who are going into such works. The difficulty has arisen with respect to their being apprenticed—persons who are to go into engineering works are almost compelled to apprentice themselves, or to be articled to some civil engineer for five years, before they can enter upon business for themselves, and this prevents their coming to the University. I took steps some years ago to start the idea of a school of practical science near Cambridge. I read a paper on the subject to the Social Science Association, and I had been in correspondence with civil engineers on the point, but they all told me that they thought that the profession generally would be opposed to it; that the regular course was, that young men put themselves in the office of a civil engineer, or in his works, and that they paid a very considerable sum of money as a premium; that the civil engineers would object to losing the services of those young men and their premiums; and, besides that, a great many of the persons in the profession believed that an entirely practical education was of more use than a partly theoretical education, and they were inclined to decry anything like a collegiate course. The University mooted the subject at one time, and our authorities corresponded with the authorities of Trinity College, Dublin, where a course had been established, but the accounts were not encouraging. As a considerable outlay would have been necessary to set up such a school, it was not to be done without a fair prospect; and the accounts which we received, both from engineers, as to the feeling in the profession, and from Dublin, and from some other educational bodies, led to the idea being abandoned for the time; but we have always been anxious to attract to us, as much as we possibly could, persons who were likely to proceed in engineering science. A certain number of persons who are going to be civil engineers come to us, but they are usually persons who have a way open to them, persons whose friends are in the profession. Practical and theoretical schools side by side would have an excellent effect on each other.

5208. Do those remarks apply both to civil engineers and to mechanical engineers? Is the system the same in both?—I think the system is the same or nearly so.

5209. I suppose a young man must go to them at about 17 or 18?—Yes, 17. He would have to stay, I think, five years generally, and that, of course, precludes his coming to the University.

5210. Have any means occurred to you for providing any system of classes, or a class of appointments by which a knowledge of natural science would bring a livelihood?—I think that if technical schools could be established something analogous to the polytechnic schools upon the continent they would furnish a resource for persons of some proficiency in those sciences. In Germany in almost every one of the states, which are



now consolidated, there was a Government polytechnic school, with a considerable number of teachers and demonstrators and professors. Of the students of natural and applied science at their Universities, some meant to go into works, or to obtain places connected with works, but a very considerable proportion looked to getting teacherships in those schools. The teacherships in schools help much to keep up the numbers of our classical and mathematical triposes at Cambridge. A very large proportion of our men, both in the classical and mathematical tripos, I should think nearly one-third, are going into schools and will take school work, or act as tutors, some only temporarily while they are looking about them for something better. I can always get a mastership for a person who is a senior optime or a second-class classic within a month or two after he takes his degree. He will get a salary of from 100*l.* to 200*l.* a year. But for a person in the natural sciences tripos there is next to nothing excepting what he may get at the University. Sometimes I have recommended to a parent that his son should proceed in natural science, as he had manifested a taste for geology, or botany, but he has said to me, "How, sir, is my son to get his bread by knowing geology?" and I have no answer to make him. I think if technical schools could be established, other schools would then take up some of those branches with the view of supplying them, and there would be a much greater demand for teachers of the different branches of natural science, and, more especially, of applied science.

5211. How would you look to those technical schools being established?—They can be established either as they are in Germany, by Government influence or with Government assistance meeting local efforts and affording help in the way of organization. Abroad they are wholly Government establishments, but to a considerable extent they are self-supporting from the fees of the pupils. I have thought that if the Government could render some assistance in the way of undertaking to provide the payment, or guarantee an income for certain of the professors, that might be one means of setting them going. The Government has now taken into its hand the Electric Telegraphs, and it will require the services of persons well qualified in certain sciences, and it might be worth its while to pay a portion of the expenses of teachers of electricity and magnetism at some of these schools. There is great difficulty attending the setting up of any branch of natural science, at least of applied science, from the great expense of apparatus, in England at present. Apparatus for all the purposes of illustration might be supplied at very much less cost than is now the case. Instruments with less finish than those usually sold would do. If a Government repository were established, something similar to the National Society's repository for educational appliances, that would very much facilitate the setting up of those schools. The Science and Art Department has much assisted the formation of art schools throughout the country, by supplying them in such a way, and also by giving them assistance in the way of organisation.

5212. Do you know any existing schools that at all correspond to your idea of those technical schools?—Not in England.

5213. Are there not any private foundations of that sort?—There was one at Chester, Mr. Rigg's school, which was very serviceable, but I believe it is not continued.

5214. Are you acquainted with the Polytechnic schools of Germany?—Yes.

5215. Do you find them generally highly esteemed on the continent?—Yes. They were well spoken of. The school is perfectly free—it is like a University, only that the students are completely at liberty to attend what courses they please. I saw a school at Carlsruhe where there was a very celebrated professor of scientific mechanism, Professor Redtenbocker, who had a large class. I talked to several very intelligent students who admitted that there were a great many students who did next to nothing; but they said that they could, if they pleased, obtain the best instruction. There

were a quantity of appliances for building—there were models, and there were some bricks which the students were taught to build with in a kind of loose way, to make arches and so on. My informants did not make much of that part of it, but they said that the regular scientific teaching was very good. A considerable amount of mathematical knowledge was required to profit by it, it was in fact an application of the dynamics of a rigid body, such as we read at Cambridge. Mechanical and geometrical drawing is very well taught there, and it is partly from the abundance of those schools that it is so much easier to get draughtsmen, and to get good plans executed, and illustrations of works in Germany than in England—they are very much more cheaply done in Germany.

5216. Is it the object of those schools to turn out young men fitted to undertake professional occupation without further practical instruction?—They would probably go into some works before they undertook any business themselves, but their services would be worth something; instead of having to pay a premium they would get a salary.

5217. Are you referring to the Real Schulen?—No, they are not the Real Schulen; the polytechnic students are from 19 to 23 years of age. The Real Schulen are schools for boys, answering something to our modern departments, but they are not connected with any classical departments. There are some schools which have what the Germans call a bifurcation, but those are generally condemned, and they do not consider that the Real Schulen are so good for general cultivation as the classical schools. There is some difference of opinion on the subject. There is a contest going on between classics and science in Germany in the educational world; but classics has the best of it at present.

5218. May the Real Schulen in any degree be considered as preliminary to the Polytechnic Institutions?—They will serve as preliminary schools to the Polytechnic schools; they teach Latin and one or two modern languages, a little chemistry, mathematics, and physics, so as to include analytical geometry and elementary dynamics of a particle.

5219. Do you think that if by any means such schools were established in England parents would be found disposed to send their sons to them?—I know very little about school work in England, but I do not think that the class of parents who now send their sons to public schools would send them to those schools. Such schools carry a lower tone in Germany than the gymnasia, which are the classical schools; the latter only would be reckoned to give a *liberal* education.

5220. Scientific works can be published with greater advantage in Germany than in England, can they not?—Yes, at a very much cheaper rate. That is partly owing to the printing being very much cheaper, and in a great degree to the fact that the illustrations, maps, plans, and designs can be executed at a very much lower rate. Some books containing large diagrams, for instance, Engel and Schelbach's Optics could not be produced in England without enormous expense, and would be very unremunerative to the publisher. The writer of any scientific or literary work in Germany who is a professor is almost sure of getting well remunerated for any publication, because it is a matter of courtesy for the Universities and the public libraries all over the country to take a copy of his work. A professor told me, "In my position I can be sure of selling enough copies to school and University libraries to pay the whole expenses of my book, and all that the public take is clear profit." Again the expense of advertising in England very often eats up the whole of the profits of the first edition of a work. I know a case of a person who sold the whole of the first edition of more than 1,000 copies, and his bookseller's account was against him. There is no advertising of books through newspapers in Germany; the publisher sends round lists of the works that he is bringing out, to all the educational and literary centres, and to all persons who

Rev.  
H. Latham,  
M.A.

10 Feb. 1871.



Rev.  
H. Latham,  
M.A.

10 Feb. 1871.

are likely to buy, so that the author is relieved of the expense of advertising.

5221. Is the German public a much more reading public as far as works of a scientific character are concerned than the English public?—They all told me that they had a large learned public and a small reading public. There are so many Government scientific departments, so many Universities, and so many of those public schools, that there are a large number of people engaged in science and in education as a business, and these buy such works, but I am generally told that the mass of the people who are not concerned in literature do not read much.

5222. Is the number of scientific works published in Germany very greatly in excess in proportion to the population, of what is published in England?—Yes, there is a larger number of works in proportion.

5223. Do you consider, generally speaking, that they are of a high character?—They have a few writers of the highest character. There is a very large number of works on experimental physics, mostly handbooks. As it is remunerative to publish, most professors write their own manual, so that there are a great number of text-books. There are also a great many scientific periodicals to which those who make any new discoveries, or new investigations, contribute.

5224. Should you like to see any measures adopted with a view to make it more easy to publish scientific works in England?—I think that if some body could point out investigations that were desirable to be carried out, and would facilitate the performance of a series of experiments, and the publication of the reports by some Government help, there would be many people who would be glad to undertake work if it were given to them to do. The record commission has found abundance of people ready to undertake work connected with their publications. I think that if any course of experiments were required as to the strength of materials, or the elasticity of substances, or other such matters, and a Government commission, or one of the learned societies were to determine what investigations were particularly required, and were to inquire for people to undertake them, there would be no lack of people fit and ready to enter upon the work. But at present the expense of such investigations and the uncertainty of any remuneration is such that only persons of large means can devote themselves to any such undertakings. A great many educational works are written by residents at Cambridge; these persons would gladly engage in something higher, but nothing else can find a publisher.

5225. How far have the new regulations at the University with respect to the various branches of physical science had the effect of introducing those subjects into school teaching?—In the modern departments at schools they have for some time been introducing what they call science, which is generally either very elementary and very popular mechanics, or a little chemistry, but I do not think that that is at all connected with what we have done at Cambridge as to the ordinary degree. Every Cambridge pass man has had to do some mechanics and hydrostatics for the last 40 years, only now he does them earlier in his course, and in a better way, I have not found that such men were any the better for the mechanics at school, rather the worse. Our natural sciences tripos may have had a little effect upon the schools, but I think that the greater part of what is done for the natural sciences tripos is learned at Cambridge, and nearly all of that which is done for the ordinary degree. When I examined for the local examinations I saw some of the papers in mechanics that were sent up from the schools, and the answers were very unsatisfactory; in fact the boys had better never have learned any mechanics at all. They had perfectly wrong views of force. I have seen the reports from time to time of the Syndicate for carrying on the local examinations, and they are generally unfavourable. The fact is that the boys although they may benefit a little by having some interest awakened in those subjects, do not get knowledge accurate enough for

an examination. They usually have two or three lessons in mechanics, or what is called science, in the week, and that is not sufficient to get them thoroughly to grasp the ideas.

5226. Do you think that boys of the schoolboy age could be taught science more completely?—I doubt it as regards the mass. Many sciences are not well adapted for school teaching. They are subjects in which a boy can always avoid work by simply saying that he does not understand. A boy hears lectures, but you cannot tell how far he attends or understands. In some of the schools boys are encouraged in a taste for natural history, for botany, and for zoology; they are led to collect specimens in play hours, and they get in this way eyes for natural objects; this is beneficial; but I doubt whether natural history should be a substitute for severer studies. The subjects can hardly be got into a sufficiently definite form to serve for lessons. It is very difficult to find fault with a boy for not doing a lesson in science; you do not know whether he cannot grasp the conceptions or will not try.

5227. Do your remarks specially apply to the teaching of mechanics?—My last remark applies more especially to physics.

5228. Then you do not look hopefully to the result of attempts to introduce any great amount of natural science teaching in schools?—I think that you might have schools mainly directed to those subjects; but then they must only take boys who have an aptitude for science. There are some schools where mathematics are taught very well, and where a certain number of boys for a year or two before coming to the University do some physics mathematically treated, as at Cambridge, particularly some of the London schools.

5229. And they do acquire some proficiency, do they not?—Yes, they acquire some really valuable knowledge; the kind of knowledge that we require for the mathematical tripos for natural philosophy. Mechanics do not come into the natural sciences tripos; they form part of our old natural philosophy tripos.

5230. Will you be so good as to give us your opinion as to the effect of competitive examinations, such as that for the Civil Service of India?—I think that the competitive examination for the Civil Service of India has at present a very distracting effect upon young men; they take in too many subjects at the same time. I will not say whether or not it may be desirable for them to study the five or six subjects that they now do, but they certainly should not be examined in them all at once. When a young man takes in a great bulk at one time he runs over the subjects and avoids all the difficulties. He will be examined perhaps in mathematics, in some parts of natural science: in English history, English literature, and classics, and he is constantly considering how he should best invest his time. It does not answer his purpose to spend any time over a difficulty, because he can find some easy part of some other subject which is more likely to be remunerative, and he never steadies his mind to any subject at all. When he is getting on tolerably well with, perhaps, mechanics, he is struck with a panic that he is forgetting his English literature, and is taken off to that or history or chemistry. There is too great a strain upon the memory in various directions, and I have found very great evil to result from the exhaustion, both physical and mental, which is occasioned thereby, particularly with those who have made two or three attempts.

5231. Does the whole examination take place at the same time?—Yes, the whole examination takes place at the same time. Within about a fortnight they will be examined in all those different branches, and in the three months preceding the examination they seem to be torn to pieces. They are in a constant fear that they are forgetting something. English literature makes great claims upon the memory. Students may be asked for the names, dates, and contents of the works of any author in the English language. This is got up very much from manuals. Although I think it is an admirable subject of study, it is a very bad one for



competitive examinations. It is damaged as an educational instrument by being so used.

5232. At about what age do they usually go in for these examinations?—They go in from 17 to 21.

5233. Do a good many Cambridge men go in for those examinations?—Formerly a considerable number; now usually two or three every year.

5234. Is it usually after they have taken their degree?—No, they could do so at first, but not now, because they must not be over 21 years of age. The evil would be much lessened if they could take in their scientific subjects—we will say their mathematics and their natural philosophy and their natural science—in one year, and their literary subjects in another. Or, what would be far better, I think, would be that they should pass some general examination, and that their proficiency in some two branches at a further examination should decide their claims.

5235. Have those that have passed the examination been generally young men of more than ordinary ability?—They were usually about the calibre of a senior optime or second class classic; some were of a higher stamp; but of late the system has fallen into the hands of certain teachers, and it has become an organized system of getting up of manuals.

5236. There is a good deal of cram, I presume?—Entirely so.

5237. Are any branches of the physical and natural sciences included in this examination?—Yes, natural science is very remunerative; it carries a large portion of marks; it comprises botany, chemistry, electricity and magnetism, geology, and zoology.

5238. Is a knowledge of all those subjects expected from the same young men?—They may take them all in, but they can get the full amount of marks by adequate proficiency in any two or more of those five subjects.

5239. (*Sir J. P. Kay-Shuttleworth.*) Did I rightly understand you to say that the young men who are ordinarily educated at public schools would not be likely to enter technical schools?—I do not think they would, so far as I know the class of persons.

5240. You are aware, however, that it has been the conviction of the heads of great mercantile firms and engineering works that a collegiate education at the English Universities carried to the age of 21 would interfere with their sons' application to the business of the firm until too late a period?—I have heard them say so sometimes.

5241. Did you not also state that you thought that the University of Cambridge was not a proper place for the establishment of a technical school?—I am not aware that I said so. I endeavoured myself to promote the setting up of one.

5242. Or rather that you had failed in doing so?—Yes, I did fail, but not on account of its connexion with the University. Many persons allowed that Cambridge had particular advantages from our possession of museums and having teachers at hand.

5243. But what were the impediments?—The impediments were that the engineering houses preferred having the young men in their workshops to their going to any college at all.

5244. Are you aware also that there is a conviction on the minds of practical engineers that whatever theoretic instruction may be given to young men, the course of their education should be mixed with the training of the hand and the eye in practical work in engineering, and also with the acquisition of sagacious habits of business?—Yes.

5245. Would it be easy to give the same facilities for such training in manual skill and in administration in either Cambridge or Oxford as could be afforded in the great centres of manufacturing industry such as Newcastle, Birmingham, Manchester, or other similar towns?—I think that there would be greater advantages for such practical training, no doubt, in the manufacturing towns, as I allowed in my paper; but when I wrote the paper, to which I have alluded, there was no movement in those towns for setting up such a school. At Cambridge we have the teachers at hand and certain

laboratories, but if they had the teachers and the laboratories at the place where they also have great workshops no doubt they would have an advantage.

5246. You are aware that of late in Manchester there has been an effort to apply a very large endowment, left by Mr. Owens, and also a large local subscription, to some such combination of practical with theoretical and scientific teaching?—Yes, I have heard of that.

5247. You are likewise aware that Sir Joseph Whitworth has created a considerable endowment, the central idea of which is that for the training of engineers the education of the hand and the eye is indispensable, although he would facilitate to the utmost scientific and theoretic instruction?—Yes.

5248. Having regard to the requirements of such schools, if they should be founded, of course they would create a very considerable demand for young men receiving the highest theoretic instruction at Cambridge?—No doubt they would, and I should be very glad to see such a demand.

5249. To afford appropriate spheres for that work?—Yes.

5250. I understand you to anticipate that such young professors having received high theoretic instruction at Cambridge, would at a very early period make themselves thoroughly acquainted with all the practical application of manufacture and of mechanical engineering works at any one of those centres of industry?—Yes.

5251. If such schools were founded that would to a very great extent fill up your own idea of what was needed for a technical college?—Yes, in fact such would be something analogous to the Polytechnic Schools that I have been speaking of.

5252. Are you aware that in the examinations by which the scholarships and exhibitions founded by Sir Joseph Whitworth are obtained, not merely great proficiency in theoretic but also considerable skill in manual work is required?—Yes, I am aware that that is so; and we have some Cambridge students who obtained them.

5253. Not entering into the question whether the opinion is well or ill-founded which is generally entertained throughout the manufacturing and engineering districts that young men should not be too long devoted to purely theoretic studies, do you conceive that schools in which modern languages and the elements of science were taught without the requirement of Greek in preparation for such technical colleges, would at length find a sphere of action?—Yes, I think that they would get a number of boys, but I do not suppose they would get the class of boys who now go to the public schools.

5254. But looking to such a district as the West Riding of Yorkshire, and the great cotton manufacturing districts, if there were modern schools connected with them in which a youth could obtain the elements of scientific education up to 17 or 18, you would expect, probably, more application to those subjects from boys who knew that they were to fit themselves to enter a technical college, than at present occurs in the merely accessory instruction of the public schools?—Yes, I think that the science taught would be probably better than where it is done two or three times a week only.

5255. If instead of being taught in three hours per week it were taught in 15 or 20 hours per week, you would expect a higher degree of success and that the boys would be able to enter a technical college with something like substantial attainments?—Yes, such boys as have any capacity for physical science.

5256. Such schools likewise would afford, would they not, a sphere for young men who had made considerable scientific attainments at Cambridge to enter upon tutorships and masterships, so that any such scheme would naturally give a considerable impulse by affording a broader sphere of action after success in the study of science at Cambridge?—Yes, it would give us a sphere.

5257. You stated, did you not, that Trinity College,

Rev.  
H. Latham,  
M.A.

10 Feb. 1871.



Rev.  
H. Latham,  
M.A.  
10  
Feb. 1871.

Sidney Sussex College, and St. John's had united for lecture purposes?—Yes, the lecturers are the ordinary college lecturers.

5258. But those lectures are open, are they not, to the students of the several colleges?—Yes, on payment of a small fee.

5259. And similar schemes have obtained in six other colleges?—Yes.

5260. Do you prefer that to the scheme that was proposed by the recent Commission of founding a University professoriate and endowing it by a tax upon all the colleges of the University?—I do not think that the two systems are antagonistic. I think we should have a good professoriate with thoroughly good laboratories and museums, but I think we must have college lectures for teaching. There is a distinction between lecturing and teaching. The professors all lecture, but only those who have laboratory work can see that the students know what they have learnt. A college lecturer teaches; he not only imparts his knowledge, but he makes it his business to see that the pupil understands. Where there is a class such as we have for the ordinary degree, it is very essential to see that they understand every step. They will require papers to be given them from time to time, and they will require *vis à voce* questions, also they should be taught as much as possible to handle apparatus. In my own lectures, in physical subjects, even for the ordinary degree, I endeavour to show, experimentally, everything that I possibly can. I lecture on hydrostatics and optics, and I try to exhibit all the phenomena which I wish my class to calculate and to explain. It is very advantageous, even for a pass student, to give him a hydrostatic balance and set him to work to find the specific gravity of a substance. They will often do this with considerable accuracy, and understand very much better than if they had merely learnt from a book.

5261. So that you conceive that this combination of colleges for lectureships might very well co-operate with and be subsidiary to the establishment of a University professoriate substantially endowed and having proper lecturers, class rooms, demonstrators, and assistants, so as to bring the whole force of the University to bear upon the cultivation of science?—I think so. I think there must be some way of teaching in which the pupil shall be on closer terms with the teacher than is possible by a University professoriate. If you do not have domestic college lectures, you must have private tuition, especially when you have persons to prepare for examination.

5262. Would you think it necessary to have any means of co-ordinating the instruction given by the college lectureships with the instruction given by the University professoriate so as to make them harmonious?—I think that the range of teaching will be pretty well defined by the examination papers. Of course the professors amongst themselves should arrange their courses and the college lecturers will readily make theirs fall in. I do not apprehend that there will be much waste. Teaching should not be exclusively in one set of hands.

5263. Do you see any use in there being a syndicate in which the professors and college lecturers should be represented and which should advise the governing body of the University upon the subject?—We have boards of studies, which were established by the last Royal Commission for this very purpose, but they have had very little effect. They are very seldom called together, and do not exercise any practical influence.

5264. Looking to the present professoriate, are there not defects of the following kinds; first, that the number of lectures is often very limited, that the time chosen for giving those lectures is not the most convenient to the students, that the subjects of the lectures have not that kind of relation which you now describe to the examination for the tripos or other honours of the University; in fact that there is not at present that co-ordination of means to ends which you would wish to see established?—Of course a professor is very inde-

pendent, and it is very difficult to enforce any laws upon the professors. Some have other duties away from Cambridge and the relation of their lectures with the tripos rests entirely with them. Some think it better to be quite independent, some would think it beneath their dignity to be preparing men for examination. A German professor would scorn the idea of giving such preparation, whereas others will work with a view to actual teaching. I should say that in the natural sciences the lectures that are given do bear very decidedly upon the tripos. Lectures on chemistry or on electricity must bear upon all the leading points of those subjects, whereas the lectures in history may be upon one period, and the examination may be on another.

5265. But looking to the University as a great centre of instruction and training of youth and regarding on the one hand the mode of arranging the form of examination in the subjects, and on the other the relation which the teaching ought to have to that examination, do you not think that the degree of independence might, quite consistently with the dignity and utility of the professors, be somewhat subordinated to the recommendations of a syndicate, in which the professoriate should be properly represented?—I can conceive such a thing to be possible. The boards were intended to effect this, but difficulties have arisen. As a matter of fact, the lectures of the professors with the exception of those where there is something to show, as in physiology, botany, chemistry, and electricity, and in the subjects where experiments are performed, as in optics and hydrostatics, cannot be considered as a preparation for the examinations—the knowledge required cannot be got by simply hearing—and the preparation of the students rests upon the college lecturers and private tutors. A professorship at a University is regarded by many rather as a post for the advancement of science than for teaching. His duties are to keep himself well acquainted with the progress which his science is making elsewhere, to advance it himself and to give opinions to the University whenever any changes affecting his department are taking place. The lecturers of colleges should be able to refer to him upon his own subjects.

5266. Is it not, however, true that all those objects may be better attained by a man who is giving a certain amount of instruction, and is it not better for the University that the instruction which he gives should be in harmony with the intentions and objects of the University?—Some scientific men have no power of teaching, no sympathy with the difficulties of the learner. I should prefer that professors should give at least one course of lectures bearing on the special subjects for degree. There are special subjects chosen from year to year. Every pass student must attend a professor's lectures, with a view to his final examination, called the special examination. A professor will often consider that those particular subjects are dealt with in college lectures, and that his duty is to give wider views of the branch of knowledge rather than to dilate on any particular subject, which, being a subject for examination, is certain to be dealt with minutely in the colleges. Here I refer to the literary lectures chiefly. The college lecturers themselves often attend professors lectures.

5267. We have had evidence given to us that it is desirable to carry out the recommendations of the commission, and to raise by a tax of 5 per cent. upon the estimated revenues of the several colleges of the University, about 9,000*l.*, and so to free the University chest from the charge of 4,000*l.* at present applied to the endowment of the professoriate. Supposing that this 9,000*l.* were obtained and to be so applied mainly to the endowment of the professoriate, does not that in itself create a necessity or a claim for a wider and general organisation of the professoriate, so endowed?—No doubt if you had a great many professors in the same subjects some further organisation would be necessary, and if paid more their duties must be more defined, but I should very much doubt whether the work would not finally have to be done by col-



lege lectures as far as the preparation for examinations is concerned. There are many subjects in which we have no examinations, and in these the professor would be the main teacher and representative of the subject in the University.

5268. Supposing that a professorship in any one of the following subjects, in chemistry, or experimental physics, or in biology, were established, and that there were associated with that professorship, assistant professors and demonstrators, and that there was work, not merely in the professor's room, but also in the laboratories or upon specimens which could be observed and handled by the students, and that was done by the application of the common funds of the University, is it not clear that all that at least ought by some controlling power to be made to have a direct relation to the studies of the University?—This is precisely what is done as regards chemistry. The chemical studies of the University are under the control of the professor, he would be concerned in fixing the examinations. There is a laboratory in chemistry which is under the direction of the professor of chemistry; he was in want of a demonstrator, but a demonstrator has been appointed. The laboratory work both in chemistry and the laboratory of practical physical science, electricity, and so forth, must be under the control of some one person, and I should be glad to see all such laboratories well provided with a proper staff and all appliances, under the control of the professors. Workshops or small laboratories in the colleges may still be useful for the private work of students.

5269. (*Professor Stokes.*) Your office connects you so closely with the under-graduates of the present day that I should wish to ask you a question which has been already asked of the previous witness. Do you think that the students generally are aware that they are as likely to gain a fellowship by sufficiently high distinction in, we will say, natural science as by distinction in classics or mathematics?—I have very few students in natural science in Trinity Hall, because ours is especially a law college; but our students certainly think that they would be entitled to emoluments from distinction in the law and history tripos, although they are ready to allow that the distinctions gained in that tripos do not rank quite with the highest distinctions in the other branches. Students will always consult their college tutor about their prospects of reward. I do not think that they can now decline to engage in a congenial study from want of a prospect of sufficient reward. The calibre of the men in the new triposes is not generally the same, taking class with class, as it is in the old triposes.

5270. What do you suppose to be the cause of that difference?—The ablest men have felt their strength in the old studies, and wish to aim at perfection in the branches in which they have had some success. A man may be a first-rate scholar at 22, but not a first-rate physiologist. I believe that it would be a pity for a person who could obtain a first class in classics, or a high place in the wranglers not to avail himself of that power, because he can go in for those other triposes in the following year. I think it very desirable that he should do both; that he should first of all obtain his wranglership, and that in the following year he should attempt the natural science tripos. I think if a person is going to apply himself to heat, electricity and magnetism, and has the power of being a wrangler, it would be a very great pity that he should not acquire, if he can, sufficient knowledge of mathematical physics to enable him to deal with the theoretical parts of those subjects. In the same way if a person was a good scholar, it would be desirable that he should cultivate his scholarship up to the age of 22, when he would usually take his degree, and that then he might apply himself to law and history. Those who go in to the law tripos only are not usually persons who could obtain a very high degree in one of the old triposes, but some who take good degrees in the older triposes in one year, in the following year obtain a high place in the law tripos.

This is a valuable addition to their distinction, and that addition is being, and has been, recognised.

5271. Supposing a young man had a special taste, we will say for natural science, and he were to pass a qualifying examination in classics and mathematics, is there anything as regards his prospect of emolument in the University to deter him from laying himself out for natural science, supposing him to be a man of ability?—In my college, and I believe in all others, if it was well known that a person was a man of ability who had distinguished himself in the first class in the natural sciences tripos, and if the examiners would testify that he was not merely at the head of the tripos or high in the tripos because there was nobody better, but that absolutely he was a man of considerable calibre, any college would be glad to give him any emoluments at their disposal. I think too that they would take account of a good memoir or monogram written by him. There is a considerable anxiety at Cambridge to promote those studies, many of which are very closely connected with parts of natural philosophy which have long been the studies of the place, namely, physical optics, and physical astronomy. Appeals from the professors for subscriptions for fittings and objects have been most liberally met; but I do not think that it would be desirable to try and force those studies into prominence, by giving fellowships to persons of an inferior calibre; because then a fellowship obtained for natural science would be looked down upon and the position would lose its prestige. No doubt there is the difficulty, whether you are first to offer the reward, or whether you are first to get the good man. I believe the only solution is, that first of all this new tripos must be subsidiary to the old triposes, so that a low wrangler may improve his degree by taking a first class in natural science; the medical school also helps them, so that in course of time we shall get a larger number of candidates, and it will then establish itself, just as the classical tripos established itself 30 or 40 years ago. The natural science tripos of last year did increase considerably in numbers; and I understand that some of the candidates acquitted themselves extremely well; and I believe that the colleges will be very ready to elect any person as soon as the examiners can tell them that he really is a person of the same calibre as those they have been accustomed to elect. I think too that many colleges would gladly elect a person who had done good work in science some time after his degree. At Trinity Hall we introduced law studentships as a reward for those who could not get fellowships; it worked well, and natural science studentships would assist that tripos. There are at many colleges scholarships of large value for natural science. Caius College has lately devoted 800*l.* a year to the promotion of natural science.

5272. (*Marquis of Lansdowne.*) With regard to the technical schools which you advocate do you consider that the education supplied at them should be of anything like a special character or merely a general scientific education, which at a later time in a man's life might enable him to devote himself to any particular art or profession?—I should suppose that if it were in a large town there would be actual technical instruction immediately at hand, so that he might have the option of obtaining it.

5273. In fact it would be an education adopted to the locality in which the school was situated?—Yes; at the Polytechnic Schools in Germany the instruction is mainly theoretical, although they are instructed in the application of theory to practice. There are workshops enough to give the students an idea of the processes which they will have to perform; although no doubt they are very inferior to what they would be able to see in a real factory.

5274. Should you contemplate anything like domestic arrangements being attached to those schools, or would they be merely head-quarters of lecturing, or would the pupils be in residence?—In Germany there is nowhere any domestic system; they are merely head quarters of lecturing. There are class rooms, and

Rev.  
H. Latham,  
M.A.

10 Feb. 1871.



Rev.  
H. Latham,  
M.A.

10 Feb. 1871.

a staff of professors, and the students live where they can. I should think it best to have a single establishment of that kind, and to let halls spring up as private affairs.

5275. On the continent, as I understood you to say, those schools are Government establishments, but to a certain extent they are self-supporting?—The Government pay a very small stipend to each of the teachers, and his maintenance is made up by fees. The plant of the establishment, the apparatus, and so on, is entirely found by Government.

5276. If such schools were to be created in this country, for example, there would be very considerable expense, would there not, at the outset, not only in finding the plant and the stipends, but also in making those stipends so considerable as to allow for the small proportion that the fees at first would bear to the amount to which hereafter they might be expected to grow when the schools got a hold upon the people?—No doubt the expense would be very much heavier in England, partly upon that ground, and partly that you must pay suitable men higher in England, because the class of persons who have ability to act as teachers have so many other things open to them. The professions are much better remunerated in England than they are on the continent, and businesses and public life are much more attractive, so that you have to compete with other and more lucrative openings.

5277. (*Chairman.*) Of what number do you consider that a class attending the lectures of a college tutor can profitably consist; how many can a college tutor manage at once?—In classics he might have 20 or 30 in the subject for a pass degree; about 10 or 12 for the higher subjects and for composition; in mathematics, I think in low subjects he might have as many as 15, but in the higher subjects not more than 8 or 10. Of course it depends very much upon how they are classified. I should always like to satisfy myself that each individual was understanding what he was about, and I should feel it necessary to look over the work that each individual had produced, either during the lecture, or afterwards before the next lecture. Each individual should have the oppor-

tunity of stating his difficulties. The difficulties raised by an intelligent man often lead to a profitable discussion.

5278. Are there any other points upon which you could furnish the Commission with any information?—I have seen in some of the evidence that I have had an opportunity of looking at that there are some who would prefer that instead of our having those which are called special examinations for the various branches of science, there should be pass classes attached to the honours tripos, and that the same examination should be given. I was on the syndicate which drew up this scheme for the special examinations, and we considered that point, and the reason which determined us was this. If you were to send all those 25 men who pass in the special subjects in for the papers of the natural science tripos, which range over a very considerable extent, they would pick up a little bit of one subject, and a little bit of another; their tutors would direct them to get up a definition here, and an experiment there, and they would read in a very unsatisfactory way, so that for the special examinations portions of each branch are taken out of the whole range, so that the students can learn those well. It was thought that it would be essential to have different sets of papers, because if we were to attach those three papers to the natural science tripos there would be a disproportionate quantity of the lower subjects, and it would be quite unnecessary. It would be only encumbering the examination, and it was thought very much better for those who did not wish to pursue the subject with a view to honours that there should be a certain portion of science marked out which they might thoroughly master. The list is brought out in two classes. The first class is arranged in order of merit, and the second class is purely alphabetical, so that there is in fact a kind of honour class attached to each of the examinations in the special subjects. These examinations are held twice a year, the tripos only once.

5279. You see no reason to alter your opinion, and you prefer the present system?—I retain my opinion, I think the plan is working very well.

The witness withdrew.

The Rev. EDWARD ATKINSON, D.D., examined.

Rev.  
E. Atkinson,  
D.D.

5280. (*Chairman.*) You are the master of Clare College, Cambridge?—Yes.

5281. You were also vice-chancellor last year, and you have held the office on previous occasions?—Yes, I was vice-chancellor last year and the preceding year, and once before.

5282. Will you be so good as to state to the Commissioners the sources from which the University income is derived?—It is derived in part from landed and funded property, but the amount of this is extremely small. I think that it can hardly be estimated at more, in net value, than about 1,500*l.* a year. The principal part of the income is derived from fees (including the quarterly payments from members of the colleges, and others whose names are on the books of the University), which of course is a variable sum. Last year it was very large indeed; larger I think than in any preceding year; roughly speaking, I should say it amounted to 20,000*l.* Then there are also appropriated endowments which are not available for the general purposes of the University, I mean those which belong to particular institutions, such as the Fitzwilliam Museum, to particular professorships, to University scholarships, and to prizes, and the amount of these I think might be roughly estimated at about 13,000*l.*

5283. The University, I believe, has no surplus income available?—I think that the whole of the income which it has available and which can safely be appropriated, has been appropriated; in fact, almost more than can safely be done in my own judgment. If we had a war, or anything which would affect the resort of students to the University, I think that there would be a great deficit, and I hardly know what

would have to be done. Certainly the various professors and others who are now paid from the fees could not be paid from any of the existing sources of income in full.

5284. Can you point out any source from which additional funds could be obtained for University purposes?—I see none except contributions from the colleges.

5285. That question has been mooted at various times, has it not?—It has, and various ways have been proposed of meeting the deficit.

5286. Will you be so good as to give us some information as to the various modes which have been suggested?—The first, and the one which seems the simplest, is the payment to the University chest of a per-centage upon the divisible revenues of the colleges. That is objected to by many members of colleges, because they think that it would not be economically dealt with by the University, and another way has been proposed by some members of Caius College, the principle of which would, I believe, be more generally acceptable to the colleges, which is this: that first of all the University and the colleges, by agreement amongst themselves, should settle what sums should be regarded as the several contributing incomes of the University and of each college; that then the council of the senate should from time to time ascertain the wants of the University, and estimate the sum required to make the necessary provision for them; that such estimates, after having been duly canvassed, should be voted upon by the University and the colleges, each college having a number of votes proportionate to its contributing income, and the University six times the number of votes pro-



portionate to its contributing income; and that, if the estimate be accepted by a majority of votes, the sum required should be provided by a per-centage upon the contributing incomes of the University and the colleges. Another way which has been proposed is by levying 10 per cent. upon the non-resident fellowships throughout the University. Another way which has been proposed, and which would only apply to one want of the University, that is to say, to the inadequate incomes of professorships, is that colleges should elect professors to fellowships in the colleges. Various combinations of those ways have also been proposed; for instance, that colleges might elect professors, and also contribute in one of the above-mentioned ways by a per-centage on their divisible revenue to the general purposes of the University, but be relieved of a part of their per-centage in consideration of their payments to the professors in the way of fellowships.

5287. Do you think that there is much probability of public opinion in the University arriving at some definite conclusion upon this subject?—I think that it could not be done without some enabling powers. I think there is a strong disposition on the part of the colleges to contribute to University purposes, but I think they have not the power at present to do it.

5288. Have they not the power to alter their statutes by application to the Queen in Council?—There is a difference of opinion upon that point, but it is, I believe, generally considered that for this purpose the authority of the Queen in Council is not sufficient without an Act of Parliament. Moreover the different colleges left to themselves would select different ways of contributing to University purposes; and it would be scarcely possible, in that case, to frame a system which the University could rely upon, and which would press equally upon all the colleges.

5289. If the Legislature were to pass some measure upon the subject, what do you consider should be its principal provisions? How far should it bind the colleges, or how far should it leave them at liberty?—I should myself think that a simply enabling Act would be sufficient, provided that it enabled the colleges, in the case of any contribution which they made to the University, if they thought it necessary, with the consent of the visitor, and by a distinct statute sanctioned by the Queen in Council, to suspend for a term of years at least such emolument as they might think might with least detriment to the college be suspended, not exceeding in amount the contribution which they made to the University, or, perhaps, only some proportion of that contribution. The circumstances of the colleges are so very different that any system of taxing, such as that which I mentioned in the first instance, would press very unequally upon different colleges, but the balance might be redressed if they had some power of suspending, for a time at all events, till their revenues were increased, any emolument or payment which they thought might be suspended with little detriment to the college.

5290. Would any of the colleges be disposed to contribute, unless it was felt generally throughout the University that all the colleges substantially contributed proportionately to their means?—I think that some colleges would, but many would not at first. Perhaps I might say, as regards my own college, that when the syndicate was recently sitting to endeavour to obtain contributions from the colleges, although many of the colleges which were willing to contribute made their contributions dependent upon a rateable sum being contributed by the other colleges, my own college did not do so, but they were willing to contribute what they thought they could without that condition, and this would apply also to some other colleges.

5291. It is not exactly clear how a mere enabling Act would get over the difficulty, because different colleges might take different views of what it was right for them to do with respect to the University, and therefore there might still be a dead lock, although each would be willing to contribute?—No doubt it would take some time, but I think that a majority of the

colleges would at once enter into a common arrangement, and that the force of public opinion would be so strong that all the colleges would within a short time come into the arrangement, especially if they had the opportunity, as I mentioned, of suspending or stopping other payments.

5292. What other payments do you refer to?—In some colleges it might be thought that a fellowship would be best suspended; in other colleges it might be thought that a scholarship or a lectureship, or some other endowment might be best spared.

5293. Has a college now no power of diminishing the number of fellowships or scholarships at its own discretion?—Not at its own discretion. It varies in different colleges. My own could do so only in the event of some great calamity, such as a fire, or other unexpected catastrophe involving heavy loss, and then the consent of the visitor would be requisite. The colleges would be, generally speaking, reluctant to give up scholarships. Indeed, great efforts have been made in many colleges of late years to increase both the number and the value of the scholarships.

5294. I think I understand from you that there is a very general feeling in the University and in most of the colleges that it is desirable in some way or other that the colleges should contribute to University expenses?—I should say so.

5295. Has your college made any provision for teaching physical science?—No provision for teaching it. We give a scholarship annually. When I say no provision I mean not directly, but the system of inter-collegiate lectures, which has been introduced, has been extended to our college, and if any of our men are students of physical science, and attend lectures in other colleges, a portion of the tuition fees is allowed for the purpose of paying the fees of their lectures. That I think is all that we have done.

5296. Have competent candidates presented themselves for your scholarship in physical science?—We have offered it for two years; the first year no competent candidate presented himself, but the second year we had a very good candidate.

5297. Have you in any instance given a fellowship for eminence in the natural sciences?—We have not.

5298. Is there anything in the regulations of the college which would prevent your doing so, if you had a member of the college who had distinguished himself greatly in those branches of knowledge?—Certainly not.

5299. Would there be any indisposition to reward great eminence in those sciences?—Certainly not; there is every disposition to encourage such eminence. I may mention, as an instance, the case of one of our fellows who took the B.A. degree in January last year, and was elected fellow in April last, and who has obtained a first class in the Natural Sciences Tripos since his election. His scholarship expired at the time of his taking his degree, and we made a grant from the scholarship fund to enable him to stay up, and prepared himself for the Natural Sciences Tripos before he was elected fellow, it being then uncertain whether he would be elected at the election next ensuing. It was known that he was well versed in natural science, and that weighed in his election to the fellowship, but of course did not entirely determine it.

5300. It had some influence in his election?—Yes.

5301. He was a good mathematician besides, was he not?—He was a fair mathematician; he was 14th wrangler.

5302. The inter-collegiate system of lectures has only been established, I believe, during the last few years?—That is so.

5303. Do you think that its results are satisfactory?—I think that they are so, and that the system is really becoming quite necessary.

5304. Is that the case chiefly with regard to the higher class of students?—I think it is so chiefly with regard to the students who are preparing themselves for one of the Honours Triposes, but I believe it extends also to those who are preparing for the

Rev.  
E. Atkinson,  
D.D.

10 Feb. 1871.



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10 Feb. 1871.

ordinary B.A. examinations in special lines. The colleges would find it difficult to give instruction in all the subjects which men may select now for the ordinary degree, and this system is therefore extended to the candidates for the ordinary degree as well.

5305. There are a very great variety of different branches of knowledge, are there not, in which a man can now obtain his ordinary degree?—There are.

5306. And that has necessitated some new arrangements?—

The witness withdrew.

Adjourned to Monday next at half-past 11 o'clock.

No. 6, Old Palace Yard, Westminster, Monday, 13th February 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

The Rev. THOMAS GEORGE BONNEY, B.D., examined.

Rev.  
T. G. Bonney,  
B.D.  
13 Feb. 1871.

5309. (*Chairman.*) You are fellow and tutor of St. John's College, Cambridge, are you not?—I am.

5310. We shall be obliged to you if you will inform the Commissioners what is done for the natural sciences at St. John's College, both in the way of instruction and in the way of rewards?—We have two lecturers, one on chemistry and one, myself, on geology. We have also a small laboratory, and by an arrangement with some other colleges our students have admission to their lectures, either free or at a reduced fee. Perhaps this schedule of our inter-collegiate lectures will best explain what I mean. (*The witness delivered in the following paper.*)

TRINITY, ST. JOHN'S, and SIDNEY SUSSEX COLLEGES.—LENT TERM, 1871.

LECTURES IN NATURAL SCIENCES.

On Electricity. (For the Natural Sciences Tripos.) By Mr. Trotter, Trinity College, in Lecture Room, No. 11. (Tu., Th., Sat. at 10, commencing Saturday, Feb. 4.)

On Electricity and Magnetism. (For the Special Examination for the B.A. Degree.) By Mr. Trotter, Trinity College, in Lecture Room No. 11. (Mon., Wed., Frid. at 10, commencing Wednesday, Feb. 1.)

Students desiring to attend either of these courses are requested to call upon Mr. Trotter at his rooms on or before Wednesday, Feb. 1.

On Chemistry. By Mr. Main, St. John's College. (Tu., Th., Sat. at 12, in St. John's College Laboratory, commencing Tuesday, Jan. 31.)

Instruction in Practical Chemistry will also be given.

Students desiring this instruction are requested to call upon Mr. Main on or before Tuesday, Jan. 31.

For Members of Trinity, St. John's, and Sydney, the fee for the Lectures in Chemistry is 10s. 6d., and for Instruction in Practical Chemistry, 1l. 1s. per term; for others the fees are respectively 1l. 1s. and 2l. 2s. per term.

On Geology. By Mr. Bonney, St. John's College.

(1.) Palaeontology. (Wednesdays and Fridays, at 9, commencing Wednesday, Feb. 1.)

(2.) Lyell's Principles of Geology. (Tuesdays and Thursdays, at 9, commencing Tuesday, Jan. 31.)

(3.) Elementary Lectures. (Tuesdays and Thursdays, at 11, commencing Tuesday, Jan. 31.)

Students desiring to attend any of these courses are requested to call upon Mr. Bonney on or before Tuesday, Jan. 31. Students of other Colleges can be admitted to these Lectures on payment of a fee of 1l. 1s. for the course.

On Structural and Morphological Botany. By Mr. Hicks, Sidney College, in the College Laboratory. (Mon., Wed.,

ments for lectures corresponding to those different branches of knowledge?—Yes.

5307. Are there any other points upon which you could furnish the Commission with any information bearing upon the nature of their inquiry?—I do not know that there are; my studies have not lain in the direction of science.

5308. Your own individual opinion is in favour of additional funds being raised from the colleges for the purposes of the University?—Yes, it is.

Frid. at 10, commencing Wednesday, Feb. 1.) To Members of the above Colleges the fee for the course is 2l. 2s.; to others, 3l. 3s.

On Physiology. The Trinity Prælector of Physiology (Dr. M. Foster), at the New Museums. Wed., Th., Frid. at 11, beginning Wednesday, Feb. 1.

The Physiological Laboratory will be open for Practical Instruction in Physiology daily. Fee for the Lectures, 1l. 1s.; for practical instruction, 2l. 2s. per Term.

5311. In the way of rewards, what does your college offer?—In the way of rewards the college offers every year an exhibition of 50l. per annum, tenable for three years. This exhibition has now been awarded three times. The first occasion of its being competed for was in the year 1868; and on that occasion two exhibitions were awarded. The college only offered one, but it awarded two. In 1869 one was awarded, in 1870 two were awarded; in June 1870 one student was elected to a scholarship of 50l. per annum, tenable until he was of standing to take the degree of M.A. Another was elected to an exhibition of 20l. for one year, and another to an exhibition of 10l. for one year, and I think on one or two previous occasions similar small exhibitions have been given.

5312. Were those for natural science?—Yes, for distinction in natural science. We have also an annual examination in natural science, which took place for the first time last year, and it was in consequence of that, that those three rewards which I last mentioned, the scholarship and the two exhibitions, were given, so that distinction in natural science is practically recognized in the college, just the same as distinction in either classics or mathematics.

5313. Were there many candidates for those exhibitions?—We have had, as far as I remember, on each occasion about 10 candidates; the number varied slightly, from 8 to 12, or something of that sort.

5314. Are the examinations in all the different departments of natural science referred to in this schedule which you have just handed in?—Yes. Perhaps I may be allowed to put in a notice which we circulate with regard to our minor scholarships, and that will show in what way we examine for the natural science exhibition. The college examination is in the same subjects; in fact, we set the same papers, and we set five additional papers; thus in the college examination there are two papers set in each subject, viz., chemistry, physics, geology, botany, and physiology with anatomy, these two being set on the



same paper. (*The witness delivered in the following statement.*)

SAINT JOHN'S COLLEGE, CAMBRIDGE.

*Minor Scholarships and Open Exhibitions for the year 1871.*

In the year 1871 there will be open for competition four Minor Scholarships, two of the value of 70*l.* per annum, and two of 50*l.* per annum, together with

Five Exhibitions of 50*l.* per annum, tenable on the same terms as the Minor Scholarships.

One of 20*l.* per annum, tenable for one year.

The Examination of Candidates for the above-mentioned Scholarships and Exhibitions will commence on Tuesday, the 18th of April, 1871 at 9 A.M.

The Examinations will consist of three Mathematical Papers, and four Classical Papers: and the latter will contain passages of Greek and Latin Prose and Verse for translation into English, and also each a passage from an English Author for the corresponding Prose or Verse composition.

In addition to the Papers above mentioned, the Candidates will be examined *visà voce* in Classics; and the Master and Seniors wish it to be understood that a Candidate may be elected on the ground of proficiency in either the Classical or the Mathematical branch of the Examination independently of the other.

Besides the ten Minor Scholarships or Exhibitions above mentioned, there will be offered for competition an Exhibition of 50*l.* per annum for proficiency in Natural Science, the Exhibition to be tenable for three years in case the Exhibitioner have passed within two years the Previous Examination as required for Candidates for Honours; otherwise the Exhibition to cease at the end of two years.

The Candidates for the Natural Science Exhibition will have a special Examination on Friday and Saturday the 21st and 22nd of April 1871, in

(1.) Chemistry, including practical work in the Laboratory,

(2.) Physics, viz.  $\left\{ \begin{array}{l} \text{Electricity,} \\ \text{Heat,} \\ \text{Light.} \end{array} \right.$

(3.) Physiology.

They will also have the opportunity of being examined in one or more of the following subjects,

- (4.) Geology,
- (5.) Anatomy,
- (6.) Botany,

provided that they give notice of the subjects in which they wish to be examined four weeks prior to the Examination.

No Candidate will be examined in more than three of these six subjects, whereof one at least must be chosen from the former group. It is the wish of the Master and Seniors that excellence in some single department should be specially regarded by the Candidates. They may also, if they think fit, offer themselves for Examination in any of the Classical or Mathematical subjects.

Candidates must send their names to one of the Tutors at least ten days before the commencement of the Examination, and if they have not been already admitted Members of the College, must send the Certificates required previous to admission, viz., a Certificate of Baptism (or Birth), and a Certificate from some M.A. of Oxford or Cambridge, drawn up in the following form:

"I hereby certify that I have examined

and I consider him qualified both in manners and learning to be admitted a Member of the University of Cambridge."

The Minor Scholarships are open to all persons under 20 years of age, whether Students in the University or not, who have not yet commenced residence in the University or who are in the first term of their residence.

A Minor Scholarship is tenable for two years, or until the scholar is elected to one of the Foundation Scholarships.

The Exhibitions are not limited in respect to the age of Candidates.

It is understood that Minor Scholars or Exhibitioners may be Candidates for Sizarships.

5315. When you speak of the college examination do you mean the general college examination of the year?—I mean the annual examination which we hold of students resident at the college. The exhibitions mentioned in the notice are offered to students not yet members of the college.

5316. So far as you can judge at present, do you think that this system of lectures which you have established in the natural sciences is likely to be successful?—I think so; so far as my own lectures go, the success if I may say so, has been greater than I had ventured to anticipate, that is to say, I have had larger classes than I had expected.

5317. Are they, generally speaking, attended chiefly by students who are also studying the older university subjects, or are they mainly attended by young men who take up those sciences by preference?—Chiefly by those who take the sciences up by preference, but I have had some who are also studying the older subjects; but it is very difficult for a man to attain high distinction in any two lines now.

5318. The Commission would be obliged to you if you would favour us with your opinion as to any alterations which would render the University and the colleges more efficient as teaching bodies, and especially as teachers of the natural sciences?—There are several points which I have noted down. It seems to me that we are very much impeded by the great want of elasticity in the University system, it is so exceedingly difficult and cumbrous a process to make any change. Perhaps I may venture to just sketch out to the Commission the mode in which a change has to be made; suppose, for example, it were thought desirable by some members of the University that at one of the examinations, say, the Previous Examination as we call it, the Little-go as it is sometimes called, a paper should be set in some branch of natural science, that question would have to go through the following process. First of all those members of the University who desire the alteration would have, in some way or other, to get the appointment of what we call a syndicate (or committee) proposed to the Senate. Perhaps, there would be a debate upon this proposition, as to whether a syndicate should be formed, then the syndicate would have to be appointed and formed, and it would have to sit and deliberate, and to report. There would then be a discussion upon that report, and finally a grace would be prepared submitting the substance of that report to the Senate, and it would then be voted upon and accepted or rejected by the Senate. That is a very cumbrous process and takes a long time, and what is worse, the persons who have to decide upon it ultimately, in fact to decide upon it in two stages, first as to whether the question should be entertained at all, and secondly as to whether the report of the syndicate should be accepted, are not in my opinion the persons most qualified to form a decision. Every Master of Arts whose name is on the boards of the University, and has been on it for about one-third of a year, has a right of voting on this question. The practical effect of this, is that it throws the decision of all these important educational questions into the hands of those members of the Senate who reside within a moderately attainable distance of Cambridge, say, within a radius of about 30 miles. Cambridge is rather a railway centre now; and it seems to me that instead of having such questions decided by the Senate (for even supposing that were desirable, we have questions now too much decided by one section of the Senate, I mean by the country clergy), it would be far better that all questions of education should be decided as much as possible by those who are engaged in the work of education; and I may say the same also with regard to the questions of finance, because of course it is quite impossible to separate the two. Not infrequently a question is rejected owing to some fear upon its first proposition; and then after dragging its slow length along for another year after some, what I should call, unimportant modifications, it gets accepted.

5319. The changes that you would like to see instituted in the University system cannot be affected by the University itself, I imagine, under its existing powers?—Not under the existing statutes; the statutes require very important changes.

5320. Has the University the power of altering its statutes by submitting them to the Queen in Council?—I think it is by an application to the Queen in

Rev.  
T. G. Benney,  
B.D.

13 Feb. 1871.



Res.  
T. G. Bonney,  
B.D.  
13 Feb. 1871.

Council. I am a little uncertain as to the exact legal process in every case, and would rather not give an opinion upon it.

5321. Is it the frequent habit of the clergy residing within a few miles of Cambridge to come in to vote on any alteration in the system of examination or the studies?—Yes, especially if by any means it can be connected with political or supposed theological questions.

5322. What is the body to which you would like to see committed the power of effecting alterations in the University system? Can you define the body that you would like to see entrusted with that power?—It would be exceedingly difficult to exactly define an ideally perfect body, but I think that the existing electoral roll, though not free from objection, would be a far better body than the Senate.

5323. The electoral roll consists of all residents within seven miles of St. Mary's, does it not?—No, within a mile and a half; it consists of Masters of Arts and those of higher degree. There are certain *ex officio* members, also those of degrees which in the University statutes are considered equivalent to Masters of Arts; of course they must be full Masters of Arts, and they must also have resided within the radius for 14 weeks at least before they can exercise their franchise. It is all defined in the Act (19 & 20 Vict. c. 88).

5324. The great majority of the persons on the electoral roll are the resident Fellows, are they not?—Yes, the resident Fellows for the most part, or ex-Fellows, or Professors, or persons engaged in college work; the town clergy no doubt, and any Masters of Arts residing in the town get a vote; and perhaps so far it is objectionable, but I think they form a comparatively small section.

5325. Are the powers of the electoral roll chiefly confined to elections, or have they any other privileges over other members of the Senate?—They are principally confined (I think I may say wholly so) to the elections of some professors, the members of the Council, and various other officers.

5326. Have you formed any opinion with regard to the professoriate, and first with regard to the present mode of election?—The present mode of election is very varied, but considering the number of professors that have to be elected by this electoral roll, and the larger number that will be in the future (for professoriates that are found out of the common University funds under "additional statutes," cap. 5, sec. 5, will have to be filled up by the electoral roll), I think a change is very desirable. Though the result of elections that I have seen has always been that which the University might be thoroughly satisfied with, I do not think that the body which elects is a good one; it is too large. It is very difficult to get men fairly and well to weigh the attainments of the candidate; they feel their individual responsibility to be small, and I think it would be far better that comparatively small boards, mainly composed of persons experienced in the particular science, where the sense of personal responsibility would be very great, should elect.

5327. That is the case, is it not, in the instance of several of the professors?—Yes, it is the case with regard to several of the professors.

5328. Is it not the fact that in some of the boards all the members are not necessarily members of the University of Cambridge?—In some cases it is so, but in very few.

5329. Do you see any disadvantage in the introduction of a foreign element, so to speak, into the boards which elect professors?—Not to a moderate extent. I should not like to see the University element in a minority, because, of course, in a body like the University, there may be peculiar wants, and a man who would be perhaps the best person for a lecturer, say in London, might not necessarily be the best for a lecturer in Oxford or Cambridge.

5330. Do you consider that any alterations are required with respect to the residence of professors?—The statute, to which I have referred, requires them

to reside not less than 18 weeks in the year. I should myself prefer that they were obliged to keep what I may call the University definition of residence; that is to say, two-thirds of the whole time of at least two of the terms. I think that, as far as possible, a professor should be compelled to be with the students and to guide and direct their studies, and should not be able to fulfil the conditions of his professorship by giving one course of lectures and making up his period of 18 weeks by residence at the beginning or end of the term, when there is no work going on; I do not, however, regard this modification as of primary importance.

5331. The regulations with respect to the number of lectures differ, do they not, in the cases of different professors?—Yes; they depend on what the University may fix from time to time. I think that most of the professors should give not less than a course of 16 lectures in each of those two terms. That would generally mean that he should lecture twice a week for the period during which the undergraduates are likely to be in residence.

5332. Some professors, I believe, give lectures considerably in excess of what you mention?—Yes, most professors lecture considerably in excess of that. The Commission will understand that I am bringing no charge against the professoriate.

5333. (*Professor Huxley.*) Will you mention what is the maximum number of lectures given by the Cambridge University professors?—I can hardly answer that on the spur of the moment, but I think the professor of chemistry generally gives six lectures a week for the three terms.

5334. Including what might be called demonstrations?—Yes, I think he is at the laboratory every day.

5335. Do you happen to know how many lectures he gives?—On referring to the published list I see he lectures six times a week for each term. This would be not less than 140 times a year; the exact number would vary slightly from year to year.

5336. (*Chairman.*) Are you of opinion that there is too great a separation between the colleges and the University?—Yes, I think that we want some way by which the University considered as a teaching body (and by that I should rather mean the professoriate) and the persons engaged in education in the colleges could co-operate one with another in the work. Formerly, within a very few years ago, you might say every college in the University was working entirely for its own hand; now those inter-collegiate lectures have very much put a stop to that, but still the University professoriate and the colleges are too much separated, each working along their own lines; and I think a great advantage would be gained by the two acting together. We should want some kind of board consisting of the professors, or representatives of the professors, and representatives of the teachers in the colleges, who could draw up educational schemes which could be carried out by the different members.

5337. For instance in your college are the lectureships in chemistry and in geology arranged in concert with the University professors of chemistry and geology?—No, certainly not with regard to my own lectureship.

5338. Would you think it desirable that the college lecturer and the professor should act in concert?—It seems to me an immense waste of a professor to set him to lecture upon the elementary parts of a subject; he ought only to lecture upon the higher branches, and to have a comparatively small class of the very best students; in fact the analogy of the mathematical and classical professors should be followed out in the natural sciences also. The lectures of the mathematical professors would be far over the head of an ordinary student, and I think it is very right that they should be. The college lecturers do all that work, and by arrangement between the college lecturers in natural science and the professors they might lighten the professor's hands, and leave him free to follow out original investigation, and to carry on the best students only with him. Again, there would be a further ad-



vantage to some of the college lecturers, that if any one of them had taken up some special point, he, by the advice and permission of the professor, might undertake all the teaching in that particular department. Most of the natural sciences have more than one side; it may happen that the professor has taken up one side, and that some college lecturer has taken up the other, and in that way the students would get better teaching than if the professor attempted to lecture upon both sides.

5339. (*Professor Huxley.*) Would you think that the co-relation between the professors and the tutors should be official or voluntary?—I should prefer it to be official.

5340. (*Chairman.*) Do you think that the system of inter-collegiate lectures and examinations might be carried to a further extent with advantage?—Yes, I think so. As far as one can judge, the inter-collegiate lectures answer very well; they have not been very long at work; it is a system which has grown up altogether within the last five years, and I think that they are answering very well. But there is a difficulty that we often feel in the fact that the colleges do not begin and end work at the same time; there sometimes will be as much as a week difference; so that perhaps when the students of our own college are up, the students of some other college who might have a wish to come to our lectures are not up, and you never know when to begin and when to end.

5341. Is any serious objection entertained by any of the colleges to establishing uniformity in that respect?—No, I do not think there is, but it is not done.

5342. It merely goes on in the old way?—Yes, it goes on.

5343. Are there reasons that would make it inconvenient for any of the colleges to adopt a general system?—I cannot think of any myself. That is one of the things that a board of education might so very well arrange, but we have got nothing of that kind. No machinery for acting in concert at all.

5344. How would you propose that such a board should be constituted?—That would be a matter which would require very careful consideration. I can only roughly give a general outline of the system. I think that you might have a representative from each college, and then say, either a representative from each branch of the professoriate, or if that was not thought enough, all the professors to form a board, and they should have considerable legislative power in all points of detail, so that they should not have to be always appealing to the general body of the University, but that they should act something like a masters committee in any public school, where, if a new book is to be adopted, or some changes made in the time table, it can be done by the masters themselves at their general meeting, and the change made without much time lost.

5345. With regard to the fellowships, might they, in your opinion, be rendered a more effective educational instrument than they are?—I think so. It seems to me that two notions with regard to fellowships, viz., that they are prizes, and also part payment for work done, are confused together. I think that these two views should be clearly distinguished, and that the two classes of fellowships which are already in theory recognised, should be practically settled. There should be one class of fellowships which should be, as it were, prize fellowships, given because a man has done something or other which has distinguished him; I think these should only be tenable for a limited number of years, that they should be of less value than the other class, and that they should not carry with them a right of residence for more than a limited period, in fact that a man should be rather more encouraged to go away from the University with his prize fellowship, than to be hanging on there. Then with regard to the working fellowships, in their case the essential condition of tenure would be residence and taking part for a considerable number of years in the work of the college. There is an inconvenience which under the present system is felt in some colleges, that the

tendency is for a man, if he has gone away for awhile and has not been particularly successful, to drift back to the college, and not having been particularly successful elsewhere he is not always very successful there. The consequence of that is that he hangs on with no suitable employment, and is often rather apt to be an encumbrance and a hindrance. I should like to see the fellows of colleges in a position more analogous to that of the masters of schools, that there should be no possibility of an idle man staying in college and wasting his time, and simply acting as an obstruction.

5346. Would you propose that a person should be elected into a working fellowship at once, or should the working fellows be taken from those who have already obtained prize fellowships?—As a rule I would rather wait for some little while, say a year or so, before putting a man into a working fellowship; but I should so provide, that if there were any very pressing reason, a man might be passed in a few days from the one step to the other; and I think that by those means, by making this distinction between the two classes of fellowships, you would be able to get funds that you might then devote to University purposes. At present in many colleges a non-resident fellow derives from the college more income than he ought to do, he derives very nearly as much as a resident fellow, who is doing all the work of the college, and that I think ought not to be.

5347. Would you include active private tutors as working fellows?—I should as far as possible endeavour to get rid of the necessity for private tutors, by having a greater number of lecturers. My idea is, that if a man manifests any tendency to specialise himself, I would at once put him into a working fellowship, and say, "Now, form for yourself if you can a class in this particular subject, to which you are devoting yourself," and then if he could make a success, one would give him a small lectureship in addition. We practically adopt that principle, even now, because all the lectureships are not of the same value.

5348. Do they depend partly upon the success of the lecturer?—No, I do not say that, but rather upon the special work that the lecturer will have to perform. Perhaps I might be allowed to go back to what I said before with regard to what my own college does, and to state more distinctly than I think I did, that our lectureships in natural science are not paid out of the tuition money, that is to say, out of the fees paid by the students for instruction, but out of the general funds of the college. Our college pays something more than 600*l.* a year in that way out of the general college funds, in addition to dividing the students' fees among the lecturers. Each student pays 18*l.* a year to the tuition fund, and that is divided among the classical and mathematical lecturers and the tutors. Then all the extra lecturers are paid out of the general college fund, and we pay, as I said, 600*l.* a year in that way.

5349. The tutors and the lecturers in classics and mathematics receive nothing as such from the college funds?—The tutors receive nothing, nor do the lecturers; only those who are appointed in extra subjects are paid from the general college funds.

5350. Would you place the government of the college exclusively in the hands of the working fellows?—Yes, except perhaps upon one or two questions of very general public interest, but upon most points I would. Any very great expenditure for instance, I think might fairly be decided by the whole body. We have something analogous to that now, inasmuch as the majority of questions in many colleges are not decided by all the residents, but by the master and the eight senior residents.

5351. Is there a considerable difference in the different colleges as to the government?—Yes. Some have seniorities, and some have not. As a rule, the larger colleges have seniorities.

5352. Have the masters as a rule, considerable power independent of the fellows?—That varies according to the statutes of the different colleges, but I should say not as a rule. Certainly not in our own.

Rev.  
T. G. Bonney,  
B.D.

18 Feb. 1871.



Rev.  
T. G. Bonney,  
B.D.  
13 Feb. 1871.

5353. With respect to the appointment of tutors and lecturers, does that rest mainly with the masters usually?—As far as I know, it varies in different colleges. In our own college the tutors are appointed by the master and seniors, and the lecturers are appointed by the master and seniors, by a recommendation from what we call the education board; that is to say, a board of lecturers and tutors, but the master and seniors are not bound to accept the recommendation.

5354. With regard to University finance, is the present state of things, in your opinion, satisfactory?—Very far from satisfactory. As a rule, our professors are, I think, very insufficiently paid. The value of most of the chairs varies from 300*l.* to 500*l.* a year. Several of them are only 300*l.* a year. The stipend of the professor of chemistry is only just being raised to 500*l.* a year. It was 300*l.* a year. Then again we shall want more professorships before long. We ought to have a professor of physiology, and I think the professorship of zoology and comparative anatomy ought to be divided. Then I think it is very probable that before long the new professorship of physics will have to be subdivided. Then again we ought to have more assistants or demonstrators. I regard them as quite as important as more professors. Then the funds which are provided for the maintenance of the museums and laboratories want increasing very much. In every department of science the University feels itself pinched for want of means, and yet I do not think that it can rightly, with its present income, devote more than it does to the maintenance of the museum and the other departments.

5355. The annual income of the University is fully disposed of at present, is it not?—Fully disposed of as it seems to me, and I think not on the whole unfairly disposed of.

5356. Therefore it is impossible that the professors should either be better paid, or other professors appointed, unless means are found of increasing the University income?—Quite so. We have now hardly any money left to purchase specimens for the museums, so much is swallowed up in what I may call management expenses.

5357. Can you point out any source from which you think the University income might be augmented?—It clearly must come from the colleges. The University has a claim upon them. These things are for the benefit of the students who come to the colleges.

5358. We have heard already from other witnesses from Cambridge, that there seems to be a sort of general admission that something of that kind ought to be done, do you think that that is so?—I think there is no doubt of that. A question bearing upon that was debated in our last general college meeting, and I suppose it is no breach of confidence to say that there was almost unanimity upon the general principle that the University ought to be aided. The difficulty is that there are many who think that the University as at present constituted is not the best manager of finance, they would like to see some important changes made in that respect, and changes somewhat of the nature which I have indicated. I think that there ought to be a kind of representative board, a sort of house as it were representing the colleges, and also representing the University, and that it should have powers somewhat similar to those of the House of Parliament, and should assign the revenue to the various departments in such proportions as may seem fit to it.

5359. Do you see any objection to one proposal that we have heard already mentioned more than once, namely, of taxing the colleges a certain per-centage of their income?—I should myself prefer to consolidate some of the fellowships into professorships, and so liberate to the University the money which they now pay to the professors, that the colleges should as it were affiliate the professors to themselves to a great extent, and so liberate the funds, and then that those liberated funds should be dealt with by this representative body. I think so for two reasons. I look upon it as a very great advantage to a college to have amongst

its members two or three professors and eminent men, and I am not quite sure whether the position of a fellow of a college would be wholly unwelcome to a professor. He would look upon the college as his second home.

5360. I suppose upon fellowships being consolidated into professorships you would not make celibacy a necessary condition?—No; in fact it is not necessary now under these circumstances. If any fellow of a college obtained a professorship which was of such a value that it was tenable with his fellowship, that is if it did not exceed a certain value, he would at once be free from all restrictions of the nature of celibacy, so long as he retained the professorship. Our statute on that point with regard to the vacation of fellowships by marriage is to this effect: "Every fellow hereafter elected shall vacate his fellowship upon marriage, unless he hold a professorship or public lectureship in the University, or the office of public orator, lecturer, or registrar in the same. No married fellow shall in any case reside in college, nor be nor act as a senior."

5361. Has your college elected any professors or fellowships?—No, we have not.

5362. But that has been done in certain cases, has it not?—Yes.

5363. I gather from what you have stated that you would provide for a considerable number of professorships, by consolidating fellowships, and allow most of the University funds to be applied to other purposes, such as you have indicated, namely, providing assistants and funds for the maintenance of the museums and laboratories?—Yes; I think that a considerable number might be provided for in that way, not all, but that we might very much relieve the University. I should be perfectly willing myself to see four fellowships in St. John's College, consolidated into two professorships.

5364. Do you think that a plan of that kind would meet with less resistance generally in the University, than any plan of taxation?—I am inclined to think it would, but I find that as many men, so many opinions, is very much the rule. It is very difficult to answer positively upon that point, as there is such a great diversity of opinion.

5365. Would your college have the power of carrying such an arrangement into effect without additional powers?—We could not reduce the number of fellowships without additional powers; I think we must have additional powers in any case.

5366. Do you think that the smaller colleges generally would be willing to agree to this plan?—I have no means of knowing with accuracy.

5367. They have of course so much fewer fellowships?—Yes. My idea was that the best way of arranging that would be to take a fellowship from each of two small colleges, to pay the joint dividend to a professor, and that the professor should rank as a fellow of the one college, and of the other alternately.

5368. As a general rule, do you think two fellowships would be about sufficient to provide for a professorship?—I think it would be a moderate endowment. It would not be as much as I should like to give, but I do not see my way at present to much more. It would probably be worth something like 500*l.* a year, rather more than less.

5369. What in your opinion would be an adequate salary for a professor? Do you think that 500*l.*, which perhaps now may be considered to be the standard of the University, is as much as you would wish?—No, it is not as much as I should wish. It is a question which a married man can answer better than myself, for a professor ought to have an income sufficient to support a moderate establishment as a married man; but I should think something like 700*l.* would be nearer to it.

5370. Very few professorships at Cambridge, I presume, come up to that?—Very few.

5371. Besides professorships in science, are you of opinion that additional professorships are required in other departments of knowledge?—Yes, for instance, we have no one to represent the modern languages at all.



I think that we ought to have either a professor, or a public lecturer in French and German at least; up to this present time we have no professor of Anglo-Saxon or in fact of the English language, but by the liberality of Dr. Bosworth we shall have that want supplied before long.

5372. Have you ever framed any estimate of the amount which either directly or indirectly the University, in your opinion, requires in addition to its present income to carry out all that you would like to see it accomplish?—No, I have not, and it would be very difficult to do that.

5373. Could the University, do you think, make a good use of an additional 10,000*l.* a year if it had it at its disposal?—Yes, I should certainly think it could, or within a very few years it would be able to do so.

5374. Do you think it desirable that all the colleges should offer definite rewards for proficiency in the natural sciences?—Yes, certainly. I do not think you will have candidates coming simply upon the hope of reward; you must say, We will give you something to begin with. If you state that if good candidates come, here is such and such a prize, good candidates will present themselves.

5375. (*Professor Huxley.*) Is not the working of the present system rather in the opposite direction, that good men are rather bribed away from natural science by finding that rewards are only obtainable in other directions?—I certainly think that up to very lately it acted in that way, and it would be a question rather of the college now. Of course I can only speak for my own college, but I do not think that any good natural science student in my own college has any reason to fear that he would injure his interests by following natural science.

5376. May I ask precisely what you mean by natural science?—It is difficult to define exactly, but I suppose the best definition would be the subjects which are examined in for our tripos. These are the regulations for the natural sciences tripos adopted by the Senate, "That the subjects of examination be chemistry, "botany, geology, mineralogy, and zoology, with comparative anatomy, and comparative physiology." Here chemistry is taken to include chemical physics, electricity, heat, and light, and after that passage general schedules are given, explaining rather more fully, which will be found at pages 40 to 45 of the Cambridge Calendar for 1870.

5377. (*Chairman.*) I believe your subjects are so treated in the natural science tripos as not to require much mathematics?—Precisely so.

5378. Has your college offered any definite reward for proficiency in those sciences?—It has offered that reward which I mentioned, namely, an exhibition, it has offered no fellowship. If we offered a fellowship it would be necessary to throw it open, as Trinity has done, to the whole University. I am not quite so sure as to the necessity of offering rewards when you have once got the students to come. The important thing I think is to offer inducements to them to come to the University, but perhaps it would be better to offer fellowships also.

5379. If a man of your college who was known and generally recognised to be very eminent in some branches of natural science, were to present himself for a fellowship, do you think that he would have a good chance of being elected?—I feel certain of it, and my reason is this, that we have elected men for distinction in oriental languages, including Hebrew, and for distinction in moral science, and in theology, apart from any question of their classical or mathematical abilities. In fact some of them have not taken any place in either the classical or the mathematical tripos, and so I suppose our college would do the same for natural sciences. At any rate, as a college tutor, I myself always feel that I can say with confidence to a pupil, "I am certain that if you show merit the college will reward it."

5380. Have many of the other colleges adopted measures of the same kind as St. John's with regard to scholarships for proficiency in the natural sciences?

—Yes; I have here a list of the scholarships proposed this year printed in the third volume of the publication called "Nature," No. 63, and it is a long one. Trinity, St. John's, Christ's, Caius, Clare, Downing, and Sydney Sussex are mentioned here. Last year St. Peter's gave one, but I do not see it in this list. They possibly may not have yet published their notification.

5381. Are some of the colleges unwilling in your opinion to take measures of this kind?—I think so.

5382. They would prefer to go on giving fellowships solely for mathematics and classics?—Yes. I am not sure whether sometimes there would not be other barriers raised. I remember one case very distinctly where a candidate was declared not qualified. It was a very singular thing, for he had all but succeeded at another college where there happened to be a very sharp competition indeed, and it was certainly a curious thing if he did so differently in two examinations so closely alike, the subjects in both being, I believe, substantially the same. Botany was one of them, and physiology was another. It was a noteworthy result, because the candidate did not belong to any Christian body.

5383. Are candidates for scholarships in the natural sciences examined solely in certain branches of those sciences, or are they required to show a certain amount of general knowledge, classical or mathematical, in addition?—In, I think, every case there is nothing more required. In our own college there is nothing more required, but we make it a condition that a man shall pass the previous examination within two years, or else he loses at the end of the two years the exhibition; but we do not examine him in anything.

5384. Can you suggest any plan by which college lectures should be brought into connexion with the lectures delivered on the course of instruction under the direction of the professors?—I think that every college lecturer, on his appointment, should be given clearly to understand, that subject to a reference to the governing body of his own college, he was to consider himself under the general direction of the professor, and that it was his duty (always keeping of course his duty to his own college in view) as far as possible to help the professor in his work. By that means the appointment of demonstrators might often be saved to the University, and then I think in return for that the college lecturers should be allowed, under fit and proper regulations, to make some use of the specimens in the museums, and of the laboratories of the University, for the purpose of illustrating their lectures. They should even, under certain circumstances, be allowed to lecture in some of the rooms in the museums; not as a general rule, but under certain circumstances, as where specimens were very fragile and could not be transferred easily, and they should occasionally use the University laboratories. No doubt that could often be done by the good will of the professors now, but I should like to see it as a matter of system. No persons can be kinder or more willing to help lecturers or students than the University professors are, but still one would like to have it a regular system, and not to depend upon the individual professors.

5385. And you would wish this to be brought about by means of a board of some kind?—I think it is just one of those things which a kind of educational board might very well arrange.

5386. Do you think that the board that you spoke of previously for managing the contributions of the colleges, could undertake the duties of an educational board?—Hardly, I think. A board of finance should be rather chosen from persons like college bursars or the heads of colleges, and the educational board should be composed of persons directly engaged in teaching, college tutors, lecturers, and University professors. Besides that, I think that the union of the two would give the board too much to do.

5387. St. John's college has a chemical laboratory, has it not?—Yes, a small one.

5388. Do you think that some subsidiary laboratories

Rev.  
T. T. Bonney.  
B.D.  
13 Feb. 1871.



Rev.  
T. G. Bonney,  
B.D.

13 Feb. 1871.

of that kind are desirable in addition to the University laboratories?—Seeing that the colleges stretch over a good deal of ground, I think that there is a convenience in having here and there a small laboratory. Time would be lost in going half a mile up to the University laboratory, whereas a man might run down for an hour or so to the college laboratory and perform any ordinary experiment. They should not have very expensive or elaborate laboratories in the colleges, but small ones.

5389. Would the University and the colleges at present have power if they chose, to establish a board such as you have been speaking of?—I should doubt it very much. It would be rather a nice question of the construction of the statutes, but I should doubt it. I do not think that there would be any chance of doing it at present under the present government of the University. I think too that the board would have no power to enforce its decrees.

5390. Would you put the ordinary mathematical lectures under the directions of such a board?—I should have it a general education board. There might be some plan devised for cutting it up into sections as a matter of convenience, but I think that on the whole it would be better to have a general educational board for the whole University.

5391. You would wish to see this board have a general control over the education provided in the colleges?—Yes, and in the University also.

5392. You would make the whole parts of the same system?—Yes, parts of the same system.

5393. (*Professor Smith.*) You stated that you would divide the fellowships into two classes, into prize fellowships, and into working fellowships; and I think you said that in your opinion the prize fellowships should be terminable?—Yes, I think a man should be supposed to have won a prize of such and such a value, and I would put no other restrictions upon it. He should hold that prize fellowship for a fixed period, whether he married or not, or whether he took orders or not. I would give it him as an annuity for so many years to help him at starting in life.

5394. Will you state the number of years that you think would be adequate?—Not more than 10 from the B.A. degree.

5395. Did I understand you to say that they should be free from the restriction of celibacy?—Yes, I should free them from all restrictions.

5396. And with regard to the working fellowships would it be your view that those should be terminable also?—I think that if a man held a working fellowship for a fair number of years, say for about 12 or 13 years, he might then be allowed to retain his fellowship either for life or at any rate until he married.

5397. Then you would propose to retain the restriction of celibacy in the case of working fellowships?—Yes, on the whole I should. There are no doubt many objections to it, but there are objections also to a large infusion of married fellows. It is a very important thing in a college to have a considerable number of fellows actually residing about in the college. There might be much mischief going on which is now stopped, or which in fact never takes place at all owing to the simple fact that there are persons in the position of fellows scattered all about the college, and I attach very great value in a disciplinary point of view to that.

5398. And you think that even with that restriction you could hope to retain permanently for the purposes of college teaching the services of really able men?—Yes, I think we should. No doubt the celibacy difficulty would be a very great one, but still I think that we should be able to retain enough.

5399. With regard to the scholarships that are given to natural science I understand you to say that it was not advertised beforehand, that so and so is to be given?—Not the foundation scholarships. Nothing given to students already in residence is advertised beforehand. We only advertise beforehand those rewards that we offer to students who have not yet commenced residence, or who are in their first term of residence.

5400. Then there are some scholarships, are there not, that are open, not to members of the college, but are advertised as being open to students who have not yet come into residence, indeed to persons not yet matriculated?—They are not technically scholars under the statutes. We call them minor scholars and exhibitioners. A scholar is actually a member of a foundation under the statutes, but it is purely a technical difference.

5401. With regard to the stimulus to education in the schools the effect is the same, is it not?—Yes, entirely.

5402. Is there every year given in your college a scholarship for natural science that can be competed for by boys in the schools?—Yes, one every year—we call it an exhibition, and in fact it is a good thing for the holder that it is an exhibition, because he is not disqualified from holding a college scholarship along with it, and the gentleman who won the first exhibition that we offered was last June appointed a scholar; so that for this year he will have his income as an exhibitioner, and his income as a scholar; in fact he will get 100*l.* for this year.

5403. You spoke of there being some doubt existing in the minds of the residents and students in some colleges as to whether the same rewards in the way of fellowships particularly would be open to them if they devoted themselves to natural science as if they devoted themselves to the older studies, classics and mathematics; is there any plan that you could suggest for general adoption by the colleges that would tend to obviate that?—I am afraid that we must leave that to time and public opinion. I cannot see my way to any plan; of course you could always evade any rule upon the subject if you wished to evade it, under the pretext of a man not being a properly qualified candidate. You must really leave it to time and public opinion.

5404. Have you formed any opinion as to whether the candidates who obtain high places in the natural science tripos are really equal in ability to the men who obtain high places in the mathematical and classical triposes?—I think as a rule they are now. You cannot quite compare place with place, but I should say that a man who gets the first place in the natural sciences tripos is, generally speaking, equal in abilities to one who takes a very high place in the classical or mathematical tripos, and in a few years I have every reason to hope that they will be quite equal. It does not always follow that a man who was say fourth in the first class natural sciences tripos would be as good as a man who was fourth or fifth in the classical tripos.

5405. Has there been any complaint, or have you heard it commented upon, that the subject of experimental physics is not counted as a separate subject in the natural sciences tripos, but is only introduced in a side manner as it were as the subject of chemical physics?—Yes, it has been commented upon, but I believe it will be corrected shortly. There is a scheme now under the consideration of the Natural Science Board, which will, if accepted, alter that; but I have not yet examined the scheme as it is not yet published.

5406. (*Professor Huxley.*) In speaking of the distribution of functions between the professor and the college lecturer, I understood you to say that you thought it might be desirable that the professor should sometimes take one special division of his subject and that the college lecturer should take another; might I ask if you do not think that that would lead to injurious results; is it not very desirable that a University professor should give the broadest and most general views of the subject, and that he should endeavour to put the students into possession of the aspect of the science as it now exists as a whole—take a concrete case for example—do not you think that it would be rather undesirable that the professor of geology at Cambridge should take, we will say, the subject of tertiary geology, with which he might be particularly intimate, and that he should leave all the rest of the subject to some college lecturer who might think it desirable to occupy himself in the matter; is it not



much more the business of the professor to instil into his students a complete knowledge of the principles of the subject and to leave to others the working out of the details?—I think you have a little misapprehended my meaning. Of course the professor should be able to give a broad and general view of a subject, but then it does not follow that he would be able to teach the details of every branch of the subject. Taking the example that you have given me, of course the professor ought to be able to lecture upon a great deal more than tertiary geology, but to geology itself there are two or three sides, there is the chemical and mineralogical side and there is the palæontological side, and that extensive one which we might call the physical or physical geography side. It might very well happen that although the professor had got a general broad view of the results of those three sides he might have turned his attention, say, either to the side of physical geography, or to the side of palæontology, or to both those sides, and might not be able to go into the latest discoveries, and the details of the latest discoveries upon the chemical or mineralogical side. He might not, for instance, have worked rocks microscopically so as to be thoroughly well up in that; but I think it would be very desirable that a student, if he has a taste in that way, should be able to go to some one who could give him a short course of lectures upon the microscopical structure of rocks.

5407. Do you think that the function of the college lecturer would be the filling up of details?—Yes, and also I may say the drilling of the rank and file students, the men who simply want to know the elementary parts of a subject.

5408. Do not you think that there might be a little awkwardness in giving the college lecturers the use of the University laboratories, ought they not to be occupied by students working under the professor or under his direction?—I was only speaking of exceptional cases. If there were some general managing board, and if the college lecturers and professors were reasonable and tolerably good-tempered men, I do not see why any difficulty should arise.

5409. What occurred to me was that the University laboratories ought to be occupied by students following the instruction of the professor and being put through their work by the demonstrator and the like, so that there would not be room or opportunity for what you propose?—That of course would be a question of the size of the laboratory. The college lecturer himself, I should hope, would consider himself a student in one sense of the word, at least his lectures would not be worth much unless he did.

5410. Would not it be better, upon the whole, to have subsidiary laboratories and subsidiary places of demonstration attached to the colleges in which that work might be done?—I think that would depend very much upon the subject, upon the number of students, and upon the kind of apparatus wanted. Some of the apparatus required is very costly, and it seems to me that it would be a pity to multiply it unnecessarily.

5411. If you contemplate only teaching the elements of the subject in the college that would not be the case?—Just so; but even now when one is teaching the elements of the subject, one would be very glad to have occasional access to a good instrument or to a valuable specimen.

5412. (*Sir J. P. Kay-Shuttleworth.*) We have had it in evidence that about 4,000*l.* is at present supplied from the University chest to the maintenance of the professoriate and the museum?—No doubt that is so.

5413. The recent commission reported in favour of a tax on the several colleges of the University for the purpose of establishing a University professoriate, a museum, laboratories, and so on, which would produce, upon their estimate of the annual income of the colleges, about 9,000*l.* per annum. I observe that you suggest that 700*l.* a year would be about a proper average salary to be given to the professors. May I bring to your attention that 9,000*l.* a year would only supply 700*l.* a year to about

13 professors?—Yes, but have you taken into consideration in making that calculation the chairs which are specially endowed? There are special endowments to some of the chairs, some are endowed from separate funds, and I cannot say, not having the materials before me, how far you have taken those in.

5414. So that besides the 9,000*l.* a year, there would be a certain amount of special endowment; are you prepared to state approximately what the amount of that special endowment is?—I could not state that without reference.

5415. At all events you would think that 9,000*l.* a year would not be sufficient for the endowment of the professorships, seeing that there are already 13 professorships endowed by the 4,000*l.* a year?—No. I look upon this 9,000*l.* a year as simply in addition to what the University now has.

5416. It has been suggested to the Commission that 4,000*l.* a year should be mainly applied to the maintenance and extension of museums, laboratories, and other similar University objects, and that the sum of 9,000*l.* a year obtained by the tax of five per cent. should be applied to the endowment of professorships. Do you think that that fund, together with the existing endowments of the professorships would be sufficient for the purpose?—I think it might at present, but of course it is very difficult to give a precise answer to a question of that kind. At any rate it would put us in a very much better position than we are in at present.

5417. You contemplate an increase of the number of professors, and that with the professors there should be a sufficient number of assistants, demonstrators, curators of museums, and so on, all of which would probably have to be provided from the University fund; taking that into account, does it not seem that 9,000*l.* a year is scarcely a sufficient sum, even if the permanently endowed professorships were to be taken into account?—I anticipate that we should find before very long that we wanted some more. Of course it would not follow that we should pay all the professors as much as 700*l.* a year, there might be professors very little of whose time by the nature of the subject need be taken up, who might have other occupations and whose residence need not be enforced. They might come and give their course of lectures, or two courses of lectures, or what not, and have some other occupation or lectures elsewhere.

5418. Might it not also be greatly to the interest, both of science and of the University, to secure the residence of some men of very great eminence by giving them a larger emolument than 700*l.* a year?—It might in some cases; but you see that depends so very much upon what the habits of the time are. Everyone knows that the value of money in that way has decreased within a comparatively very recent period, and it may decrease more, or possibly the mode of life may become more simple, and so the claims upon a man's purse may become less.

5419. As one mode of providing a central fund of the University for the creation of professorships, and all their accessories, you spoke of the consolidation of fellowships into professorships; I apprehend that for that purpose there is no existing power in the University?—To the best of my belief there is none. We should have to apply for an extra statute.

5420. But there would be at all events even then no co-ordinating power so to regulate the action of the several colleges as to produce such a result as the consultative board may desire for the whole University. Such a result, for example, as the Education Board, which you propose, would desire to bring about?—Of course the council of the University might propose a scheme to the Senate, and if the Senate accepted it I have no doubt action might, in that rather roundabout way which I sketched at the beginning, be taken, but there is no immediate way of doing it.

5421. But the impediments to the operation of that power are in your conception very great at present, and likely to prove rather an unpleasant obstruction?—I think so.

5422. And you want to confer upon the Educa-

Rev.  
T. G. Bonney,  
B.D.

13 Feb. 1871.



Rev.  
T. G. Bonney,  
B.D.  
13 Feb. 1871.

tional Board, or upon some central authority working with greater facility, and representing fully the wishes of the University on those subjects, a power to co-ordinate the operations of the individual colleges if they consolidate their fellowships into professorships, or if they contribute in any other way to the University professoriate?—Yes.

5423. Should not such a board likewise have a general power of regulating the studies, so as, for example, to see that there was some co-relation between the work of the lecturers in the colleges and the professors, that the time applied by the respective colleges should be such as not to prove, as you have described, a hindrance to the studies, and that the subjects and number of the lectures should be brought under some kind of regulation?—As I said before, I think it would be well to keep your finance department, and your teaching department separate, and not to have the same board for both.

5424. But that such power as I have now described should be conferred upon the Education Board?—There should be a central authority in education as well as a central authority in finance, with considerable power of alteration in detail, and with an appeal to the electoral roll or to some body analogous to that, in cases where now they would appeal to the Senate.

5425. As to the fellowships, I understand you to wish that there should be one class of working fellows, and you thought it expedient that they should at least work for a definite number of years, and probably then have the power of retiring upon a non-resident fellowship?—No; I should not let them go away even then. I would give facilities for travel or for further educating themselves; but certainly not let them go away and treat the college as a bank.

5426. You would still desire that the colleges and the University should have the benefit of their residence in a disciplinary point of view, and of their character and experience?—Yes; and of their advice. I take it that the number of those who would remain would be comparatively small.

5427. As respects the non-resident fellows, I understand you to wish a limitation of time?—Most certainly; which in most colleges is the case now. In St. John's, if a man does not take holy orders, or is not engaged in college work, he ceases to be a fellow at the end of 10 years from the B.A. degree.

5428. Taking into account the operation of such regulations, and also of public opinion upon the use of fellowships, would it not be tolerably clear that in this way the colleges would be to a great extent re-imbursed for any charge that was put upon their funds for the University professoriate, museums, and such like, that it would be simply a transference of the fund, by the limitation of non-resident fellowships, and so on?—I am not quite sure whether I rightly apprehend the question; but I do not think that it would seriously impair the incomes of those who were engaged in college work. I do not think it would make much difference in that way, because, of course, as you would give more work to the resident fellows, you would make the resident fellowship rather more valuable than it now is; so that what you take from the non-residents you would practically hand over to the residents; therefore I do not think that it would affect the general total of the income materially.

5429. (*Professor Stokes.*) In the answer to one of the questions which was proposed to you, you appeared to contemplate the introduction of a paper on natural science into the previous examination, which is the pass examination, that your students have to undergo. Am I to infer from that that you are of opinion that it would be desirable to introduce a certain minimum of natural science as a necessary qualification for a degree?—I meant to express no opinion whatever. I simply meant to take a purely hypothetical case.

5430. May I ask whether you have formed any opinion upon the subject?—On the whole my opinion is rather against it. I do not like minimum qualifications.

5431. In the two classes of fellows which you con-

template, is there any provision for fellows residing and not perhaps taking part in college tuition, but giving themselves to original research in some branch of science or literature?—When I spoke of a working fellow as lecturing, I did not mean that he should lecture necessarily to the same extent that the college lecturer now does, giving up nearly the whole of his time to it, it would be enough if he gave a course of lectures (the number to be determined by the college), upon the subject of his research, or some cognate subject, which I think would be no great tax upon him, and by intercourse with the men he would really gain as much in other respects as he would lose by the few hours that he had devoted to his teaching.

5432. You would make a certain amount of lecturing obligatory on the resident fellows?—Yes.

5433. Are we to understand that you would attach particular professorships to particular colleges, so that the holder of a certain professorship should immediately become *ex officio* a fellow of a particular college?—I think that would be the most convenient way of doing it. Of course there might be a little difference of feeling; some colleges might have a preference for a particular professor, but I think that would not be a serious difficulty, and I believe this would be the only way of managing it.

5434. Do you see any objection to introducing into the governing body of a college, a person who has not been chosen by the governing body, but is, I might say, forced upon them from without?—I see no objection, but I am not prepared to say that in every case I would give him quite the same right of voting as another fellow. I have been speaking on the pecuniary side of the subject.

5435. Then you would place a professor as a fellow in an inferior position to the others as regards the government of the college?—No more inferior position than he is placed in now if he is married. In our own college he cannot be a member of the seniority; nothing more than that. The governing body of a College is rarely less than eight, and often more, and the presence of one man, or you might say of half a man, because in a college of small size they would only now and then have a professor, would be no very serious evil; and I am not sure whether new blood would not be rather a good thing.

5436. Do you think that such a forced introduction, if I may say so, of a member from without into the governing body of a college would be generally acceptable in the University, or would be resisted?—I think that some would not mind it; some would dislike it, no doubt. There would be great diversity of feeling. I think that to a large number of men it would not be unacceptable.

5437. Another scheme has been before us, according to which if the colleges were to contribute to the University, and if they pleased to elect a professor as a fellow, the amount of his fellowship would count as part of his stipend, which, in case he were not elected a fellow, would be paid by the University, and the college would deduct from the sum which they had to pay to the University, the amount of his stipend as fellow; is that a scheme which you think would work?—I think my own would be simpler. No doubt it would work, but I should prefer my own.

5438. It would not have the objection of forcing on to the governing body a person who was not elected by them?—It would not have that objection, certainly, but I do not think that that would be a very serious one.

5439. If I understand you aright, in one of your answers you proposed to appropriate one or more fellowships to natural science?—I said that I thought it was a very doubtful point which was the better plan, that if you did appropriate fellowships to natural science, then you must throw them open to the whole University, but I rather prefer our own system. It has the drawback no doubt that men away from the University do not so well know that they will be rewarded.

5440. You are of opinion that in order to make the



present system work thoroughly, nothing more is required than that it should be generally known that distinction in natural science is as likely to be rewarded as distinction in classics and mathematics, unless there be reasons quite apart from the University, such as a future career, which would determine a man to classics or mathematics rather than to natural science?—So far as regards scholarships I think that every college ought to offer an immediate inducement for students to come up to the college, but after that I think it might be fairly left to time.

5441. (*Marquis of Lansdowne.*) I think you propose that the correlation of University professors and college lecturers should be subject to some board of studies, should you propose that a similar board of studies should control the relation to each other of the inter-collegiate lectures of which you spoke?—The lectures would come under that board. The inter-collegiate lectures are in most cases merely private arrangements between the lecturers of the colleges, which have an informal sanction from the governing body, at least it is sometimes formal and sometimes informal.

5442. Do you anticipate that they would produce some good results, or rather that they would work as well as they have hitherto worked, if the influence by which they were grouped was not an internal influence, but an external one?—I cannot see that there should be any reason why one should fear any difficulty on that score.

5443. I am not quite sure whether I understood you correctly; but I think you said that in the event of a division of the fellowships into prize fellowships and tutorial fellowships, you would attempt to absorb the private tutors by converting into lecturers any men with a known speciality for any subject?—Yes, that is my view.

5444. Would those lecturers be tutorial fellows?—They would lecture in consequence of their being resident fellows.

5445. But are there not men with such specialities, who are private tutors and take a great number of pupils and who are, nevertheless, not holders of fellowships?—Yes, there are some cases.

5446. Those I presume would not be affected by such a change?—No, they would not. I suppose that we can hardly ever do away entirely with private tuition, but it might be certainly reduced.

5447. The drift of your answer, if I understood it aright, was that such a change would minimise this taking of private pupils?—Yes.

5448. (*Dr. Sharpey.*) If I understood you rightly, the examinations in the natural science tripos are not restricted to mere written questions and answers but are partly practical, are they not?—There is practical work in chemistry, but there is no *viva voce* at present. I happen, however, to know that a *viva voce* is proposed in that change of which I spoke.

5449. Is there any description of specimens, for example mineralogical or geological?—There is now description of specimens.

5450. Is there anything like a description of physical apparatus, of the methods of using it, and so on?—I am not aware that physical apparatus is ever brought down for the student to use. Specimens in geology, mineralogy, botany, and the like, are brought, and they are told to describe those. One morning is devoted to practical work in the chemical laboratory, and I know that they are going to propose that there should be always a *viva voce* examination.

5451. Speaking generally, what do you think is the real motive of a student in Cambridge who engages in the study of natural science, is it to gain a good position in the examinations, or is it really to gain a good education in a branch of science?—I suppose that the motives are very much like those of men in the world in other matters, they are mixed. It would depend upon the individual, some men act from high motives, some from low motives, and some from mixed motives, probably the greater number are in the third category.

5452. Have you formed any opinion as to the general

effect of competitive examinations of a high order in which there is a great strain put upon the attention and energy of candidates, throughout their career—of the effect of that in reference to the exercise of original observation or independent thought, and in short whether such system of examinations has a tendency or not to favour a disposition to original inquiry?—It is very difficult to say. I think that the strain of an examination and preparation for it seriously injures some men in their health, whereas other men are vastly better for the trial of a competitive examination. No doubt there is a little tendency to over exalt the value of a success in an examination of that kind. A man may think that because he has got very high in the tripos, therefore that he has done for life his work as a student. Still I think that the evil is outweighed by the good on the whole.

5453. Would there be any way of distinguishing the students, and rewarding those who had been successful in original research, in the laboratories for example, or in the schools of science at Cambridge?—I think that is a thing which, speaking as an examiner, as a lecturer, and as an elector, the college would very gladly reward. Original power is just the thing that one welcomes most. One looks with some little contempt upon a man who is merely an examination man, who has got a sort of sponge-like power of absorbing facts, and having them squeezed out of him again.

5454. Do you think that the system in Cambridge really tends in the way that you would desire?—Yes, I think it does on the whole.

5455. You think that it tends rather to encourage original research, than mere success in the examinations?—Yes; I do not mean to say that the result is as great as one would hope for, but I suppose it is as great as the success of any other scheme. I think it is as much as one can fairly expect. What perhaps does more mischief than anything else, is the quantity of work that is generally thrown upon the residents; most of them are at the present time overworked, and have not time for original research.

5456. And they are in a constant state of anxiety about the examinations?—Yes; there is a number of examinations, and a large quantity of University business of various kinds, which is a good deal necessitated by the complex system which I have spoken of; then there is the system of private tuition, and the waste of power involved in holding separate examinations in separate colleges, when the examinations might have been common to two or more colleges, and there is a waste of power in lectures. The ablest men and those more willing to labour of course suffer most from all this, so that they live a kind of mill-horse life, through a large part of the year, and they get thoroughly tired and cannot go in for original investigation.

5457. If I understand you rightly, there is no previous condition required for a candidate for one of those natural science exhibitions of which you spoke; he does not require to pass a previous examination, does he?—No, none whatever. He must only have this certificate, "I hereby certify that I have examined A.B., and consider him qualified, both in manners and learning to be admitted a member of the University of Cambridge." That must be signed by some person with an Oxford or Cambridge degree, not less than M.A., that is all which is demanded.

5458. It has been stated that there is a difficulty in finding a sufficient number of candidates of sufficient merit really to take those exhibitions, do you agree with that opinion?—I can only speak for my own college, and we have had no difficulty. We elected two last year, and I should have been thankful if we could have elected three. We only offered one exhibition, but we gave two, and I should have been glad if we could have given a third.

5459. (*Chairman.*) You have stated that at present there is a certain amount of distrust of University management in point of finance. Do you think that if

Rev.  
T. G. Bonney,  
B.D.  
13 Feb. 1871.



Rev.  
T. G. Bonney,  
B.D.  
13 Feb. 1871.

all financial matters were entrusted to the members of the electoral roll, that body would inspire confidence?—I think that would be better, but I should trust still more to a representative financial board, representing the colleges and the University. I should give them very great power over the finance.

5460. Would you place almost the whole disposal

The witness withdrew.

Rev.  
J. Cartmell,  
D.D.

The Rev. JAMES CARTMELL, D.D., examined.

5462. (*Chairman.*) You are master of Christ's College, Cambridge?—I am.

5463. You have also on more than one occasion I believe, held the office of Vice-Chancellor?—Yes, three times.

5464. And you have taken an active part in University affairs for many years past?—Yes, I have.

5465. Certain measures have been adopted in the University during recent years for the encouragement of scientific instruction, especially in the natural sciences; are you of opinion that further advance in that direction is desirable?—Certainly.

5466. Can you point out somewhat more particularly what you think should be done with that view?—I think that the incomes of the existing professors are inadequate and ought to be materially increased. There may be room for additional professors in natural science, but I think that the increase of the incomes of the existing professors is the first want.

5467. I believe the income of very few of the scientific professors exceeds 500*l.* a year?—Very few.

5468. In many instances it is much below, is it not?—The Woodwardian professor of geology and the professor of chemistry each receive 500*l.* a year, and the newly-established professor of experimental physics will receive the same. The professors of human anatomy, of comparative anatomy and zoology, of botany, and of mineralogy, and the Jacksonian professor of natural and experimental philosophy, each receive 300*l.* a year. The Sadlerian professor of mathematics receives half the annual income of Lady Sadler's benefaction, which amounted last year to 571*l.* 7*s.* 3*d.*, probably a fair average. I need not inform the Commissioners with regard to the income of the Lucasian professor of mathematics; and with regard to the incomes of the Plumian professor of astronomy, the Lowndean professor of astronomy, the Regius professor of physic, and the Downing professor of medicine, I do not possess accurate information.

5469. Have you formed any opinion as to the standard at which you think the salaries of the professors should be fixed?—I think a standard not lower than 500*l.* a year, and I should be glad to see it somewhat higher than that. I think somewhere between 500*l.* and 800*l.* a year would be a reasonable sum.

5470. Do you think that additions to the professorial staff are required?—Not perhaps a great many. I should think if one or two or three more professors were added, that would be sufficient, but the first care should be to improve the incomes of the existing professors, with the addition of, say, two professors.

5471. In your opinion do any of the professors require additional assistants?—Yes. An additional assistant has very recently been provided for the professor of chemistry; he certainly did require such assistance very urgently, and I should think that he requires still larger assistance of the same nature.

5472. And is further expenditure also required in providing apparatus, and museums, and laboratories?—Yes, certainly. We require apparatus, and we require places to put it in and to use it.

5473. For all those purposes does the University require a large addition to its disposable income?—I think so.

5474. Are you prepared to make any suggestion as to the mode in which that sum could be provided?—There seems to me to be only one source from which it

of the University funds in the hands of this financial board?—Yes, almost the whole.

5461. In other respects, should you like to see the composition of the electoral roll modified?—I should, but I have never yet been able to see my way to any scheme which would be better than the present, it is so very difficult to draw up one free from objections.

can come, and that is by a tax upon the colleges in some shape or other.

5475. We have heard from witnesses from Cambridge, who have already appeared before us, that that appears to be a growing opinion in the University. Do you agree with that?—I am disposed to do so. The nett income from endowment of the University is rather less than 2,000*l.* a year. The remainder of the income of the University chest comes from fees paid by candidates for degrees, and from the capitation tax of 17*s.* a year paid by every member of the University whose name is on the boards or register.

5476. The whole of its present income is already fully disposed of, is it not?—Yes. I think that at this present time it would not be prudent to make any additional charge of importance upon the income of the University chest. I might mention, that when I said that the endowment of the University chest was not more than about 2,000*l.* a year, I did not include the special endowments of the various professorships, and the special foundations.

5477. Do you know how much those special endowments amount to on the whole?—The nett incomes from the special endowments of the scientific professors, received through the Vice-Chancellor, were last year as follows:—

	£	s.	d.
Dr. Woodward's benefaction	-	-	467 13 0
Lady Sadler's do.	-	-	1,142 14 6
Dr. Smith's do.	-	-	44 16 6
Government pension	-	-	34 3 6
Total	-	-	£1,689 7 6

The Regius professor of physic, the Lucasian professor of mathematics, and the Plumian and Lowndean professors of astronomy respectively, receive for themselves the income of their special endowments; and the Downing professor of medicine has a share of the dividends of Downing College. In all these cases I do not know the incomes.

5478. Are you prepared to point out any plan which you think would be the best for raising such contributions as we have been speaking of?—I am ready to state my own opinion about the matter. It is embodied very much in a paragraph in the Report of the Royal Commissioners (I mean the Commission of Inquiry that was appointed in 1850), though I differ somewhat from the conclusion at which they arrive. In their Report (p. 202) they say: "We recognize the prevailing practice by which fellowships are looked upon as just rewards of eminent merit, and as helps and encouragements to the further prosecution of study or general advancement in life. But at the same time, bearing in mind that the fellows of colleges were by the original constitution of the University in the position of teachers, and have laborious duties assigned to them arising out of the old scheme of academical instruction, while in modern times the fellowships are frequently held by non-residents, and rarely contribute in any direct way to the course of academical instruction, though their emoluments far exceed their original value; we have thought, that in consideration of this practical exemption from the performance of such educational duties, it is no more than reasonable and equitable in return, that an adequate contribution should be made from the corporate funds of the several colleges towards rendering the course of public teaching, as carried on by the



"University itself, more efficient and complete." That was the opinion that they expressed, and I entirely agree with it in general terms. The Parliamentary Commission (appointed under 19 & 20 Victoria, c. 88) tendered to every college in the University a statute taxing the distributable annual revenues of the college at five per cent. Of the 17 colleges four (including my own) accepted the statute; but the other 13 colleges negatived it, and therefore it did not become operative upon any, because one provision was that it was not to become compulsory upon any college until it became the statute of all. I do not think, however, that the mode of taxing the colleges by a general tax upon the distributable income is by any means the fairest that can be devised.

Though fully adopting the view that the practical exemption from educational duties, which were imposed by the original constitution of a college upon the fellows, makes upon the persons so exempted a fair and reasonable claim of providing means for the performance of such duties by others, yet it does not seem to me to follow that a general tax upon the whole distributable income of a college, which would fall equally upon those who do such work and those who do not, the best and fairest mode of proceeding. Every college, from its foundation up to the present time, has consisted of a master, fellows, and scholars, all of whom, without exception, were subject originally to the condition of habitual residence within the college as a general rule; and this condition was practically observed until a comparatively recent period. By the statutes of colleges generally the fellows of colleges had certain duties prescribed to them in their college and the University, which were to be carried on from term to term; and a fellow was not allowed to be out of residence except for a moderate and fixed number of days in the year. The great feature of their duties was the pursuit of science and learning, and they were first to acquire for themselves and then to teach others. Sometimes, but not always, ecclesiastical duties were attached as well. As I have been informed by an old man, now dead, the residence of fellows of colleges was regarded generally as obligatory until nearly the middle of last century. From that period, however, notwithstanding the statutable obligation, the practice arose of fellows of colleges being non-resident if they pleased. And the parliamentary commissioners, when remodelling the statutes of the several colleges, have fully recognised this liberty, and relaxed the obligation of residence, so far as regards fellows, though they have continued it—and most properly so—upon the master and scholars. In many of the colleges a power is probably reserved of recalling a fellow into residence for a temporary purpose; but, so far as I know, there is not in any college a general power of compelling a fellow to habitual residence if he desires to be non-resident. And, taken by itself, I highly approve of this liberty. I think it a great advantage that a fellow should be free to go where he thinks proper, and to employ his talents and acquirements as best he can; and that, if non-resident, he should be exempt from those duties of instruction which the intentions of the founders of colleges, and the early usages of the University, undoubtedly imposed upon him. But in return for so valuable a privilege, I think it fair and reasonable that a non-resident fellow should contribute something towards the support of those who actually perform the important duties which originally would have devolved upon him in respect of his fellowship. I think, therefore, that a difference should be made between the incomes of a resident and a non-resident fellow (or in other words that the income of a non-resident fellow should be taxed), and that the aggregate of such differences should form a fund for providing instruction. It may perhaps be said that the instruction fund so raised would seem to belong to the colleges respectively rather than to the University at large. But it must be borne in mind that originally the instruction provided in a college was in a great measure sufficient for those who were to be instructed within its walls; but that is not so now, especially as

regards natural science. The obligation upon a college, which was originally fulfilled by the fellows, of instructing its scholars, still remains, and yet cannot be sufficiently fulfilled without extraneous help from the professors. It seems to me, therefore, fair to say that if a fund were raised by taxing the income of non-resident fellows, such fund might very properly be applied to the support of those who give instruction in the University, i.e., of the professors. I think it also fair to assume that a resident fellow will do what is equivalent to bearing his share of the obligation I have attempted to describe, by taking part in the instruction given in the college, or in maintaining its discipline and order, or in rendering assistance in the general administration of the college or the University. This scheme was submitted to the colleges by a syndicate as an alternative scheme a year ago.

5479. Could your scheme be worked in such a manner as to ensure a certain definite fixed sum for University purposes?—Not a definite fixed sum perhaps, annually, but it would practically work so as to give, taking one year with another, a very ample sum. There is a very great draught upon the University for fellows of colleges, for various important employments out of the University, and many of them are in consequence non-resident.

5480. Do you think that the income is larger than is required, looking upon the fellowships as prizes?—Yes, looking upon a fellowship as a prize previously won by University distinction. A fellowship is an invaluable thing to a young man, for it at once gives him a start in life. If he is disposed to remain in the University, its employments and endowments are open to his pursuit, and he can employ the start there; or a fellowship may set him forward elsewhere, if he thinks fit to go. But for this latter purpose I think that a less sum than non-resident fellows generally receive now would be sufficient. 200*l.* a year would seem a liberal assistance in giving him a start.

5481. Would it not be almost necessary for your scheme that each college should determine what proportion of its fellowships should be disposed of as non-resident fellowships?—No, I think not.

5482. A college might be disposed, might it not, to keep all its fellows residing in Cambridge, and then it would contribute nothing to the University?—Certainly; but a college could not do that—there is no power in a college to do that.

5483. You think that might be left to the discretion of each college to determine?—It would operate I conceive according to the individual views of the fellows. If it was required that a fellow, for instance, should receive (I will take the figures that were put in the scheme) 85 per cent. of his income whether he was resident or not, but that the other 15 per cent. of his income should depend upon whether he resided two-thirds of each term or not—that is to say, that 5 per cent. of his income should be taken off for every term that he was absent (two-thirds is the period of time that is required to what is called keep a term in the University) that would be a self-acting scheme, it would have nothing to do with the college at all.

5484. Would you propose that the resident fellows should be required to do some college work, or would you simply require them to reside a certain portion of the year?—I would simply require them to reside a certain portion of the year in term time. The prize would not be sufficient to induce them to reside merely as idle men. To active-minded men who have been trained to work it would be most distasteful, I conceive, as a general rule now-a-days, to reside in college without having something useful to do.

5485. Then you would take off about 15 per cent. of the income of a fellow who did not reside?—Yes.

5486. Have you calculated at all what sum it might be expected to bring in?—I have made a very rough calculation, and I hope the Commissioners will take it only for what it is worth; but my impression is very strong that not less than 32,000*l.* a year, and probably more, is paid to non-resident fellows—to persons who do nothing in the University at all; 15 per cent. of

Rev.  
J. Cartmell,  
D.D.

13 Feb. 1871.



Rev.  
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D.D.  
13 Feb. 1871.

that would be about 5,000*l.* a year. There is, however, nothing magical in 15 per cent. Possibly the per-centage might be larger, at the same time exempting from the tax all fellowships of not more than 200*l.* a year.

5487. Do you think that that would be adequate for the requirements of the University?—I see that the master of St. John's says that he thinks that 10,000*l.* a year would be required, but, as seems to me, that is in excess of what we require or could employ at present with any advantage. My own impression would be that 5,000*l.* or 6,000*l.* a year would be ample for a long time to come. I am sure that now 5,000*l.* a year would be felt to be a perfect mine of wealth.

5488. Do you think that the scheme which you have sketched out would be more likely than any other to receive general support from the colleges?—I am bound to say that it did not receive very much support when first propounded; but individuals have since described it to me as a most just scheme; but as a scheme, when it was submitted to the colleges, it was not received with much favour. I am, however, of opinion that it is not desirable to leave to the University itself the settling of any scheme. I think that there should be some authority exterior to the University, ultimately to do that. I do not think that we shall ever agree amongst ourselves upon any scheme whatever. I agree with the master of St. John's in what he said on that point, and I would adopt the view that he expressed.

5489. Would you contemplate its being left to the legislature to determine ultimately?—I would rather that the legislature gave limited powers to two or three or five persons of great eminence and responsibility to hear what different persons said in the University, and then to determine according to their discretion what the scheme should be, subject to an appeal to the Privy Council similar to that given in the Cambridge University Act. Of course this is a mere rough sketch, and if any such view were adopted it would require a good deal of consideration and working out; but such is rather my notion. I do not think that an Act of Parliament would be the best way of settling it in detail. I think it would be very much better left to persons of great eminence and high station, who would be responsible to the world for what they did.

5490. You think that the University, if left entirely to itself, is not likely, under present circumstances, to agree to any scheme?—I do not think that it is.

5491. If the plan of a regular per-centage from all the colleges were resorted to, it would be in the power of each college to carry it out much in the way that you have suggested; they might make a difference, might they not, between their resident and non-resident fellows?—Yes; but I should be sorry to exercise such a power in my own college, and that it should be a matter of discretion or of vote amongst us, whether or not a fellow should be required habitually to reside. It seems to me very undesirable that the master and fellows of a college, who live in a community, and constitute its governing body, should discuss and decide questions affecting the personal—as apart from the corporate—interests of each other. The colleges are admirable bodies for administration, and for carrying out the general objects and duties for which they are founded. I venture, although at the head of one of them, to say that their affairs are managed with integrity and intelligence and prudence; but in the interest of internal peace I should not be disposed to increase their discretionary power in the direction indicated.

5492. Another plan has been suggested, of indirectly furnishing the University with additional funds, by converting some of the fellowships into professorships. Have you ever thought of that plan?—Yes, I have. I would rather contribute from the funds of the colleges and make the professors independent of any college. I do not think that they would amalgamate very well with the society of the college, and it can make but very little difference to

them. I would rather leave them as a class as they are now, leaving to the colleges the power which many of them have exercised with very great advantage, of electing professors to fellowships if they thought fit. I think the colleges should have ample power for doing so; but I would rather not make it compulsory to attach a professorship to a college fellowship.

5493. We have heard that a certain amount of distrust exists in Cambridge as to University management in point of finance. Do you think that any distrust of that kind exists?—I do not think that there is any reason for it. The University funds are all administered in the light of day, and under graces of the Senate, which must be approved in the first instance by the council of the Senate; and it seems to me that one especial function of the council is to watch over and to regulate and restrain the expenditure of the University, and so far as I know the University funds are as a rule administered well and thriftily. I do not agree with what I have heard some persons say, that the administration is extravagant. I really do not think it is.

5494. Turning now for a moment to your own college, you have offered, have you not, certain scholarships for eminence in the subjects which form the subject matter of the natural science tripos?—Yes.

5495. Have good candidates presented themselves?—Very.

5496. How many scholarships do you offer annually for that purpose?—The plan has only been begun within a year or two. We did not offer any specific number, but we thought that we would have a tolerably high standard, and take as many good candidates as we could get. We took two the first time, who came up to a very creditable standard.

5497. Do you think they were as good men in their way as those whom you elect to scholarships in mathematics and classics?—I think they were. We are quite prepared to extend the plan. The only thing that we require is that the candidates must give a reasonable hope of being able to pass the first University examination, called the previous examination, at the proper time.

5498. You think it indispensable that they should have a certain amount of general culture?—Yes, enough to enable them to pass the previous examination, certainly.

5499. Have those whom you have elected to natural science scholarships yet arrived at the time at which it would be necessary to pass the previous examination?—No, but I have every reason to hope that they will be able to pass.

5500. If they do not pass will they lose their scholarships?—Yes, or at least the scholarships will be suspended till they do pass. It is rather a scandal for a scholar of a college not to be able to pass that examination, which is a very easy one.

5501. Those scholarships of which you have been speaking, I presume, are for students who have not come into residence?—They came into residence in October.

5502. But the scholarships were awarded before they came up?—Yes, we have an examination in the spring of students who propose coming into residence the following October.

5503. Do you propose to award any scholarships or other rewards of the same kind to those who are going through their undergraduate course?—Yes, we propose to examine the natural science scholars yearly in natural science, and if they are going on well and distinguish themselves, we shall increase their scholarships, as we have the power to do.

5504. You are under no disabilities with regard to appropriating your funds for the encouragement of natural science?—No, I think not.

5505. You could grant a fellowship, could you not, for eminence in the natural sciences?—Yes; if a candidate obtained the degree of Bachelor of Arts by distinguishing himself in natural science we could elect him a fellow certainly, and we would do so I am persuaded.



5506. If a man of your college had given satisfactory proofs of having acquired great distinction in any branches of natural science, do you think that your college would be disposed to give him a fellowship?—I have every reason to say so. As one of the electors, I should be much disposed to vote for him myself, and I believe that the fellows of the college who are the other electors would take the same view.

5507. You do not have examinations for your fellowships, do you?—No.

5508. Very few of the smaller colleges have, I believe?—Very few of the smaller colleges; they take the University examinations as their test.

5509. Perhaps you would hardly consider a high place in the natural science tripos alone a sufficient qualification for a fellowship?—A high place I should.

5510. (*Mr. Samuelson.*) You have spoken of a scheme of which you approve, for providing a fund for the purposes of the University; assuming that that scheme or any other scheme were adopted, do you believe that the whole or the greater part of the funds arising from either of those schemes would be available for the purposes of instruction in natural science?—I should imagine that a sufficient amount of them would be so. My own notion would be that any fund raised upon whatever principle from the colleges should be a trust fund, the purposes of the trust to be distinctly specified, and to be the support of the professors and of the general teaching in the University; and I would have the trust specified either in an Act of Parliament, or in something that was equivalent to an Act of Parliament, and then I would leave the fund to be administered by the University itself, and to be appropriated from time to time as might be required by the purposes of the trust.

5511. But inasmuch as this Commission is concerned entirely with the question of the advancement of science, should we be safe in calculating that the greater proportion of the fund raised by any of those schemes would really be available for natural science, or, in your opinion, would there be other material claims upon such a fund?—I think that the claims of natural science are greater at present than any other. There are no doubt claims for other professorships, but I think that the claims of natural science are greater than any other at this present time.

5512. Do you think that it is probable that those claims would receive their due attention from the governing body of the University?—I think so.

5513. I find that in the course of the evidence given by gentlemen connected with Cambridge, the professorships of Anglo-Saxon, German, and French, have been mentioned; they would naturally absorb some portion of that fund, would they not, if they were founded?—Yes, but I should myself think them all of very inferior importance to the professorships in natural science. One of the Commissioners now present has as good a means of judging as I have, and would tell you, but I should think that would be the general opinion in the University.

5514. You have spoken of its being desirable that some tribunal external to the University should determine the best means of raising the fund of which we are speaking; is it your opinion that it would be sufficient that a Commission should be appointed for that purpose in the hope that its recommendations would be adopted by the University, or do you think that it would be necessary to take legislative powers of a somewhat more binding character?—I should prefer taking legislative powers, provided that the objects to which they were applied were limited. I should be very sorry indeed to see a Commission re-opening all the questions that were opened before the Parliamentary Commission. Those questions have been settled happily now, and I should regret to see anything like such a wide field of inquiry opened again. I wish not to be understood as disparaging what the Parliamentary Commission did—very far from it—great good, I think, resulted to the University from its labours; but I think very great evil would result from

opening so wide an inquiry again, and I do not see the need of it. I would limit therefore the field very much, but I think that so far as it goes it would be better that what was done was done under an Act of Parliament; that authority should be given by an Act of Parliament to determine certain points, but limiting and defining very distinctly the points to be taken into consideration and determined.

5515. In fact that the Commission should be appointed by law, and that the Commission should itself have legislative powers?—That would be my view, provided that those powers were limited, and only extended over a well-defined and confined area.

5516. (*Sir J. P. Kay-Shuttleworth.*) I observe that the subjects of examination for the natural sciences tripos are defined in the regulation to be chemistry, botany, geology, mineralogy, and zoology, with comparative anatomy and comparative physiology, and the Commissioners have understood that there is also an intention to appoint a professor of experimental physics?—Yes, the professorship has been already established.

5517. Looking at those separate chairs of natural science, what do you think it would be wise to regard as the proper average income for the professors of those chairs?—I should say certainly not less than 500*l.* a year, and I think that 800*l.* is the extreme limit; somewhere about half way between the two, or about 700*l.* a year, I should think, would be a very reasonable sum.

5518. 700*l.* a year for six chairs would require an income of 4,200*l.* a year. Then with respect to several of those chairs it would be necessary, would it not, in some way to provide (if they are to be thoroughly efficient) for assistant professors, demonstrators, and other accessories, laboratories, curators, museums, and so on?—Yes.

5519. Then all those several functionaries you would have to provide for from the University fund?—I think that if the professors were paid from this new fund the University chest might very fairly be called upon to provide, if I may so speak, the machinery.

5520. I do not mean the existing University fund, but from some fund to be confided to the University, either the existing or some other fund?—Yes; the new fund that has been spoken of as being to be raised from the colleges I think should be mainly confined to providing the stipends of the professors.

5521. We have understood that the existing fund at present applied by the University to professors, museums, and so on, amounts to about 4,000*l.* a year, and that out of that provision is at present made for about 13 professorships, and likewise for the extension of the museum buildings, the keeping up of the museums, and other accessory expenses. Taking into account the further necessity of providing for assistant professors, curators, and demonstrators, do you think that a fund of 8,200*l.* a year would be sufficient for the whole of that; for the professorships of the natural science tripos, and all the accessory means of tuition?—I should think so. It is difficult, without having the whole thing more specifically before one, to give a decided opinion at once; but I think that a smaller sum than 8,200*l.* a year might practically be made to supply all our needs in those directions.

5522. There is a fund likewise, a special endowment, is there not, to certain of those professors which might be accessory also?—Yes, no doubt there would be that in addition.

5523. Supposing that natural science became a more general and popular study in the University, and that, by the improvement of the public and endowed schools, students came more generally prepared to enter upon those studies, and by the increasing the opportunities to make a living by the application of such studies in future pursuits in life, there should be a large accession of students to the University who desired to study the natural sciences, is it not obvious that such a change would require a very considerable development of the central means of teaching in the University?—Yes.

*Rev.  
J. Cartmell,  
D.D.*

13 Feb. 1871.



Rev.  
J. Carnell,  
D.D.  
13 Feb. 1871.

5524. Among which are the extension of museums and museums buildings, provision for a proper curatorship, provision for all the subordinate appliances of teaching accessory to the professorships and the co-ordinating of that with the work of the college?—Yes.

5525. For all that would it not seem to you upon full reflection that a larger sum might be required (even taking into account the special endowments) than the existing 4,000*l.* a year and the additional 5,000*l.*?—If there was a very large accession of numbers there would be a large accession of income too. I do not propose to diminish the payments of each member of the University. He pays a capitation tax of 17*s.* a year, he pays a fee at the previous examination, and he pays a fee upon taking his degree, and if there was a large accession of numbers then the aggregate of those fees would be proportionately increased.

5526. And they would increase the University income?—Yes, they would go into the University chest, and increase the University means.

5527. In relation to this matter have you considered whether or not it would be desirable to have somebody more directly representing the teaching power of the University, to regulate the studies, rather than confining it, as at present, to the council of the Senate?—I think it had better be done under the direction of the Senate. I should doubt whether it would be desirable to confine it either to one person or to a small body. I think it better to leave the Senate to deal with such a question from time to time. It might be desirable to have an administrative committee of that kind. I think that is very possible. I have not considered that question, but I think that is one of the things which should be left to the governing body of the University itself to determine from time to time, and that no external direction or advice would be desirable.

5528. But considering the possible growth of the number of students of natural science in the University, the great extension of the professoriate, and its accessory means of instruction, the necessity of co-ordinating the central studies with the local preparation of the colleges, and likewise the desirability of there being some harmony in the relation of all the colleges towards the central studies, does not out of that arise an additional necessity for the existence of some regulating force in the University which should represent the professors and the colleges immediately with respect to the regulation of their studies?—I do not think that there is more required than we have now. I think it best to leave to the colleges their independence as being the most proper judges of their own interests. It is their practice to adapt their teaching and general course of instruction to the needs of their students, with reference to the University course, and I should be very sorry to have the independence either of the colleges or the University interfered with.

5529. Are there not differences of this kind, differences as to the period of the commencement of terms, differences as to the period at which the professors give their lectures, and differences as to the period during which they give their lectures, and is there at present anything to co-ordinate the action of the professors with the action of the tutors of a college on any special study?—With regard to the period of beginning residence, that I think is pretty much the same at all the colleges, or at least only varies by a few days. I do not think that any legislation is required as far as that is concerned; and with regard to the professors, there are various boards of studies to one or other of which each professor belongs, and he is required, as a general rule, to adapt his scheme of lectures to the approval of the board, and I do not see the need of other directing authority. The board itself ought to require that the lectures should begin at a proper and reasonable day and conclude also.

5530. You do not therefore think that, looking to even a great extension of the professoriate for studies in natural science, there should be any new form of representative central regulation within the University itself?—I do not see the need of it, at this present

time, and I think if the need arose it is one of those questions which the University itself both has the power to deal with and would be peculiarly competent to deal with. I should be very willing to leave it to the council of the Senate either to devise a scheme themselves or to delegate the devising of a scheme to a Syndicate. I think it a thing which belongs specially to our administration, and if any difficulty arose it could very easily be obviated by ourselves.

5531. You consider it undesirable that the colleges should be left to determine the number of their non-residents or to put any limitation upon their income?—Yes, certainly.

5532. Then you would have some, either external or internal, power to interfere, but of a central character?—If there was any general scheme of taxation I think that it should be determined by some external authority and not by ourselves, and it should be a uniform scheme applying to all. I would desire to add that I have no rooted objection to the scheme that the Parliamentary Commissioners proposed, of a tax upon the distributable income; if nothing better could be done I am quite willing to agree to that. Possibly such a tax might be levied, so as to supplement the fund raised as I have previously suggested. I desire also to add that whatever scheme of taxation of the colleges be adopted, care should be taken not to injure the present vested interests either of fellows of colleges or of others. I have understood that such is the practice of Parliament in general legislation; and it seems to me that justice requires it to be observed in this case.

5533. (*Professor Stokes.*) Assuming, in accordance with your opinion, that it is but just that non-resident fellows should be at a slight disadvantage, in point of income as compared with resident fellows, do you think that the scheme is better according to which a certain per-centage of their income is deducted, than that according to which the tenure of their fellowships is made limited?—I think it is very much better that they should have their income taxed, rather than that the tenure of their fellowships should be limited. I am of opinion that it is not a good thing to limit the tenure of a fellowship. I would much rather tax their incomes and let them hold their fellowships as long as they needed them or as long as they were disposed to do so under the general conditions of the college and University.

5534. Do you think it is better for the holders of fellowships?—I think it is better for the holders of fellowships, it makes the fellowships more valuable; and I think it is more expedient generally, and besides I do not think that limiting the tenure would necessarily give any income under the scheme, because you might only replace one non-resident fellow by another non-resident fellow.

5535. Of course, if you limit the tenure, you may assume that the succession will be quickened if no change is made in the number, and that being the case, by reducing so large a number of fellowships, you might ensure the same number of vacancies as if the tenure were not limited and the number larger; so that it comes to the same thing in the end, does it not?—I would not say so positively. But recurring to the last question, there is a very striking passage in the report of the Oxford Royal Commissioners (p. 167) on this very point, where the evidence of Archbishop Whateley is quoted. The Archbishop says that he conceives a limitation in time would greatly impair the practical value of a fellowship, without making much difference as to the succession, and he gives his reasons for this opinion. The Commissioners add, "We concur with the Archbishop."

5536. (*Chairman.*) In your opinion has any inconvenience ever arisen from non-resident members of the Senate having the power to vote upon questions affecting the University studies?—Perhaps there may be inconvenience occasionally, but at the same time, I think, taking it altogether, the advantage of our being connected with a large number of persons counterbalances it. I do not think the inconvenience



at all so great as to require any interference with the privilege. When a really desirable scheme is proposed, it can after all only be postponed for a while; public opinion is much too strong to enable any set of persons merely from prejudice ultimately to hinder it. I think the balance of good would be very much against taking away the privilege of non-resident members of the senate.

5537. You would not like to see the power of voting on matters affecting the studies confined to members of the electoral roll?—I can see no sufficient reason for such a provision.

5538. If such a Commission as you have suggested were appointed by Parliament, its duty would in the first instance probably be to ascertain the requirements of the University in point of funds?—Yes, and those would be very easily known.

5539. It would be necessary, would it not, for the Commission to determine, in the first instance, how large an amount of money was required from the colleges?—Perhaps so.

5540. They could scarcely decide upon any scheme without making up their minds as to the actual needs

of the University, and supposing that point to be settled, they would then have to decide as to the mode of levying contributions?—Yes.

5541. And you would confine their power simply to those points?—I would indeed. I think we might be spared a great deal of difficulty if their powers were limited in that way.

5542. It would scarcely be in their power to act at all without having the means of ascertaining the needs of the University?—Perhaps not, but the needs are pretty well confessed.

5543. We have had different opinions as to the amount. Some have placed it at 10,000*l.* a year, but you are of opinion, are you not, that 4,000*l.* or 5,000*l.* would be sufficient?—I think, perhaps not less than 5,000*l.*, but I think 10,000*l.* an excessive sum.

5544. That would be a point upon which the Commission would necessarily be obliged to inquire, would it not?—I think so, and probably a statement would have to be drawn up in detail.

5545. Is there any other point upon which you could give us any information?—There is nothing that occurs to me at present.

The witness withdrew.

The Rev. WILLIAM GEORGE CLARK, M.A., examined.

5546. (*Chairman*). You are Fellow and Vice-Master of Trinity College, Cambridge?—I am.

5547. You had also formerly been a tutor of the College, had you not?—Yes, for several years.

5548. And for several years also Public Orator?—Yes, for 12 years.

5549. Has not a good deal been done in Cambridge, during the last few years, for the promotion of scientific education?—Yes, a good deal.

5550. Do you think that the University has need of further steps in that direction?—I think very great need.

5551. Will you point out the matters in which such further advance is required?—Not being myself a student of science, if I were to describe exactly what was needed I should be speaking only at second-hand, and I should rather prefer to speak upon the best means of getting the money that is required. I may, however, state that I have the best authority for saying (for in fact all are agreed) that our museums are extremely defective, that we want very much more extensive buildings, that we want additional professors and demonstrators, and that several of the existing professorships ought to be more largely endowed, stricter conditions as to lectures and residence being at the same time imposed.

5552. Assuming that it is desirable that all those requirements should be met, have you thought of any plan by which the requisite funds could be procured?—I think that the best plan would be by a contribution from the colleges, according to a certain per-centage, upon the distributable income. There was a plan which was proposed by the last Commission, and which was actually embodied in the statutes of several of the colleges; but at that time there was a power given to the colleges, that if two-thirds of the body objected to a statute proposed by the Commissioners, the objection was held valid, and the statute was not inserted. I think there were three or four colleges which did not object. At Trinity College, the college to which I belong, it was accepted unanimously, and it stands now among our statutes; and it will take effect as soon as a similar statute is introduced into the statutes of other colleges. This statute provides that the college shall, when the other colleges do the like, subscribe, for University purposes, five per cent. of its distributable income; and the distributable income is defined to mean allowances in money or otherwise, as rooms and commons, to the master, the fellows, and the scholars.

5553. Do you think that opinion in the University at present, so far as you have been able to judge, is

more in favour of a scheme of that kind than it was at the time of the Commission?—Very much more so, I have no doubt whatever.

5554. Amongst those who are favourable to contributions being afforded by the colleges in some shape, various other schemes have suggested themselves, have they not?—Yes, I have heard of some other schemes, but none which I think would be so effective as that. I think that it would be quite possible, in addition to such a contribution from the colleges, to make some alterations in respect to the masterships of colleges which might render them more available for educational purposes than they are; as, for instance, if the choice of the electors were restricted to those who were or had been either University professors, or who had been engaged in college tuition, or held office in a college for a certain number of years. I think that in that way a mastership might be made available as a kind of additional endowment, or in some cases, perhaps, even as a sort of retiring pension for professors of the University.

5555. Do you desire that the masters of colleges should actually take part in instruction?—I think that would be very desirable; and by such a plan as I have proposed, you would secure that they would be able to do so with advantage.

5556. Do you think that masterships might be combined with professorships?—I think that would be very possible.

5557. Have you any expectation that a plan for providing contributions from the colleges will be carried into effect by the University without interference of any kind from without?—I think it extremely difficult to get anything like unanimous consent, because I believe that any single fellow of any college who objected to his vested interest being damaged, as it certainly would be by a deduction of five per cent. immediately from the distributable revenue, would have a right to object, and actually the power of stopping the proceedings; and on that ground I think that it would be done much better by legislative interference.

5558. Would you propose that a plan in all its details should be incorporated in an Act of Parliament, or that some machinery should be devised by the legislature, with power to frame a scheme and to carry it into execution?—The latter had occurred to me as being the most convenient. Of course on such a point I speak with great diffidence; but it seems to me that if an Act of Parliament appointed Commissioners with power to levy from the colleges a contribution not exceeding a certain per-centage upon

Rev.  
J. Cartmell,  
D.D.  
13 Feb. 1871.

Rev.  
W. G. Clark,  
M.A.



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M.A.

13 Feb. 1871,

their distributable revenues, they would take evidence and judge from that evidence what the proper *quota* of each college would be, and they, I think, might be empowered to carry it into effect.

5559. Do you think public opinion in the University would be prepared to receive the appointment of such a Commission without any very strong repugnance?—I think there would be very strong repugnance amongst some persons, but I think there is such a growing opinion that it is absolutely necessary for the credit of the University and consequently for its prosperity, that those who would object would be in a decided minority. I think that it would be hard to take away at once, say five per cent. of the incomes of all fellows, but that might be provided for by giving the colleges the power, if they pleased, by a vote of a majority of their number to abolish or suspend a certain proportion of the fellowships, so that the present holders of fellowships would not suffer. But in some colleges, I think, they would be quite prepared to submit to the sacrifice. I think I can say for the college to which I belong that everybody would be quite willing to submit to the sacrifice, and by additional economy, perhaps, in administration we might make up for it.

5560. Has the tendency of college incomes been to increase of late years?—The general tendency is to increase, but of late years our colleges have been running out their leases, so that the actual revenue in some cases has temporarily diminished.

5561. Then there is a prospective increase which will accrue in the course of a certain number of years?—Yes, certainly; but for the last 15 years, I think, at Trinity College we have been running out leases and refusing to take fines, and we had not till last year borrowed any money, as we had power to do, to compensate us; so that actually the dividends have been very much smaller than they would otherwise have been, and even smaller than they were.

5562. Those are farm leases, I presume, to which you refer?—Yes.

5563. They were held for a certain number of lives, renewable by fines?—I think they were generally leases of 20 years, renewable from time to time; and also the great tithes with which the college is largely endowed, were also leased. Those leases were renewable by fines, and by refusing the fines we make a present sacrifice with a view to the future advantage of the college; and as the fellows have made that sacrifice without any reluctance, I imagine that they would make the other.

5564. One or two other plans have been suggested to the Commission, one of which was a proposal that the colleges should consolidate some of their fellowships into professorships: and another was that a difference should be made between resident fellows and non-resident fellows, that non-resident fellows should submit to a large amount of taxation, while resident fellows remained unaffected. Do you think that either of those schemes might be made to work?—I think the former might be made to work. It was done at Oxford, I think, in several cases; I mean consolidating certain fellowships into professorships. But with regard to the latter scheme, I should not like to tax non-residents as such, because it would have a tendency to drive persons into residence who would really be of no use when they were there. I should not like to have any persons in residence who were not actually employed either in college or University education, or else in literary pursuits of their own, and I think that to tax a person merely because he was non-resident would have a tendency to bring into residence a number of persons whose presence would not be desirable. I think that non-resident fellowships should be terminable without any exception, and also all fellowships where the holder was not employed either in college or in University work.

5565. After what period do you think non-resident fellowships should be terminated?—I think that the

rule which prevails at Trinity and St. John's is a very good one, namely, seven years after taking the Master of Arts degree, because when a young man comes up to the bar at that time, after seven years in all probability he is able to make his own way, but it is a most valuable assistance to him in the meantime.

5566. But at present the fellowship does not terminate if he takes orders?—If he takes orders it does not terminate at all so long as he remains unmarried, or does not take one of the larger college livings.

5567. But you would make it terminable equally, whether he was in orders or not, provided he did not reside?—I think so, provided he did not reside and was not engaged in college work. By the present statutes of Trinity College if a fellow not in holy orders is a tutor, lecturer, or bursar or steward of the college, he continues to hold his fellowship so long as he holds the office, and if he has held the office for 10 years uninterruptedly then he may retain his fellowship for life, if he be not married.

5568. Residing in the college and taking private pupils is not considered as college work, I believe?—No, it is not.

5569. Do you think that students of science should be required to pass a previous examination in any respects differing in its nature from the ordinary previous examination?—Some time ago Lord Lyttelton, as chairman of the Endowed Schools Commission, addressed to the Chancellors of Oxford, Cambridge, and London, a letter suggesting that Greek should no longer be made a *sine quâ non*. A syndicate was appointed at Cambridge some time ago, of which I am a member, to examine the question. The syndicate have not yet reported, but we have come to the conclusion to recommend that in the previous examination any student who pleases may, instead of Greek, select to be examined in French and German. What we propose is that there should be passages set in French and German taken from standard authors, which the student must be able to translate at sight, that a few questions on grammar arising directly out of those passages shall also be asked, and that there shall be another paper in which a passage of English prose shall be set to be translated into French or into German as the candidate may choose. We shall require translation from French and German with translation into French or German. The report has not yet been presented, but it will very soon be presented to the Senate, and if the Senate accepts it, it will become the law of the University.

5570. And would it allow of a person obtaining a degree without any knowledge of Greek?—Yes; he will be able then to take honours in natural science, and take the degree of B.A.

5571. Will a candidate for the ordinary degree be able to obtain it without Greek?—No; because for the ordinary degree there is another examination, in addition to what is called the previous examination, one called the general, in which Greek is required.

5572. And you do not propose to make any alteration in that?—We thought there would be no necessity for it, because the object which was proposed in Lord Lyttelton's letter was to allow persons who were going to devote themselves to science, to get the University degree without the knowledge of Greek. Persons who were going to devote themselves to science would certainly, as I suppose, desire to take honours in science; they would hardly be content with taking the ordinary degree, and then passing one of the special examinations.

5573. Candidates for all the four triposes are exempt from the general examination, are they not?—Yes, for all the honour examinations.

5574. They pass through the previous examination, and then they may devote themselves exclusively to their own course of study, may they not?—Yes, they may pass the previous examination as early as the second term after coming into residence with the additional subjects, the additional subjects being elementary algebra, trigonometry, and mechanics.



5575. (*Professor Smith.*) You stated, I think, that the plan which you mentioned for the previous examination of the students who intended to read natural science had not passed from the hands of the syndicate?—No, it has not. The report is not yet published; but what I have mentioned is the principle of the report.

5576. Can you form any impression whether such a plan as that is likely to be approved of by the University?—The Senate is such a very large, scattered, and heterogeneous body, that I should not venture to prophesy what decision it may come to.

5577. Supposing this plan were adopted, what amount of mathematical knowledge would be required from candidates for natural sciences?—They would have to pass an examination in the first instance in the first three books of Euclid and the first six propositions of the sixth book, arithmetic, elementary algebra, elementary trigonometry, and elementary mechanics.

5578. (*Sir J. P. Kay-Shuttleworth.*) A student of natural science entering the University by such an examination as the syndicate has proposed, might go on, might he not, to honours and into the government of the University, having chiefly a knowledge of natural science and modern languages?—Yes. Latin would be indispensable, as much as is required in the previous examination, which is a very small amount.

5579. So that the great staple of his knowledge would be natural science and modern languages?—Yes; but even I should say as to these modern languages a very small modicum of knowledge would be exacted, excepting that we should require in modern languages what is called composition, that is to say, the power of translating from English into either French or German, while in Latin, which is set in the previous examination, we only require that they shall be able to construe a fixed subject and to answer a few very simple questions on the accidence of the Latin grammar.

5580. What I desire to arrive at is that the honour students of the natural science tripos, could, having the attainments which you have defined, come into the government of the University?—Yes.

5581. And by so much the government of the University would fall into the hands of men who had a greater knowledge of natural science than those in the mass, who probably now govern the University?—That is to say that those persons would be introduced amongst the governing body; but whether the government would fall into their hands would depend of course upon their comparative number.

5582. You describe the Senate as at present a large, scattered, and heterogeneous body, looking to the production of a considerable central professoriate in the University, and a great extension of the means and appliances of the study of the natural sciences, together with the teaching power, do you think that it would be altogether wise to confine the regulation of that form of studies to the Senate alone, or would you desire that there should be some board of education, constituted out of the University, of a more representative character?—I think with regard to the regulation of purely educational questions, a very much smaller body, a body of residents at the University, and of persons actually engaged there, and those who for a series of years have been engaged, would form a much better body for deciding upon purely educational questions, than a very large body like the Senate.

5583. Provided that natural science instruction receives great extension, there will necessarily arise many questions affecting both the action of the professoriate and its relations to the colleges which will require immediate and new decisions, you would confide those, would you not, to a body having intimate knowledge of the internal constitution and working of the University?—I think it would be very much better certainly to do so. The only thing is that we must

take care not too much to trench upon the privileges of the Senate, because it is from the payments of the masters of arts that a great portion of the revenue of the University is derived.

5584. On the other hand, the accession of natural science students, if it were considerable, would greatly add to the revenues at the disposal of the University?

—Yes, certainly. The University revenues are derived almost exclusively from those two sources. The landed property and the small quantity of Government stock which it holds produces only a gross sum of about 2,600*l.* a year, while from the other sources, the quarterly payments, the fees, and the fines, I think its income is about 20,000*l.* a year. For the use of the museums, there is a sum set apart which is called the Museums Maintenance Fund, which is 1,500*l.* a year. There is another sum set apart, called the Museum Building Fund, of 1,000*l.* a year, and a General Building Fund of the same annual amount. The sum of 1,500*l.* a year, which goes to the maintenance of the museums, is extremely inadequate for the purpose.

5585. Could you give the Commission any opinion whether you think that a tax of five per cent., which we estimate as producing 9,000*l.* a year, would be sufficient to enable the University to establish and maintain the professoriate with all its accessories?—For the present I should think that it would be amply sufficient. I do not think I should rate the amount to be obtained from a five per cent. tax quite so highly. I have endeavoured to find it out as well as I can, and although I do not wish to speak with confidence at all, I should not rate the distributable revenue of the aggregate of the colleges at more than 150,000*l.* a year. I believe the Royal Commission estimated it at 180,000*l.* Taking the lower estimate, I should imagine that for our present purposes it would be quite sufficient.

5586. You would not, however, like a limitation to that five per cent., but would prefer that power should exist to enlarge hereafter the means to be applied by the University to central teaching?—I think it extremely desirable that the same legislative Act which allowed the Commissioners to assess five per cent. for the present, should also contain a power for imposing more at a future time when the needs and claims of the University should require it.

5587. (*Professor Stokes.*) If the tenure of a fellowship in the case of a resident depends upon his holding certain college offices, such as that of lecturer, and if the appointment to those offices is in the hands of the general body of fellows, do you not think there is a tendency to elect a man in order that he may retain his fellowship, although perhaps he may not be the very best who could be found for lecturing purposes?—I think that there might be such a tendency, but I cannot point to any instance in which it has really operated.

5588. That probably would be less likely to occur in a large college like your own, where to be a lecturer is rather an exception, than in the case of a small one?—Yes; there are, I think, 16 or 17 tutors and lecturers now in Trinity College.

5589. (*Marquis of Lansdowne.*) In the event of the probable recommendation of the syndicate being adopted, and a degree conferred for science with a minimum of Latin and a certain knowledge of modern languages, should you think it desirable to change the title of the degree, and to make any distinction between the mark you set upon a man who left the University with that degree, and the mark that you impress upon a man who leaves it with the existing degree?—I do not see any reason for the change. They have the title of B.A. conferred upon all, and I do not see that anything would be gained by alteration.

5590. You do not think that at the present moment public opinion expects from the possessor of a B.A. or a M.A. certain literary qualifications as distinguished from scientific, which the holder of one of those new degrees could not possess?—I hope that the holder of one of those new degrees would possess rather higher literary qualifications, being able to translate French

Rev.  
W. G. Clark,  
M.A.

13 Feb. 1871.



Rev.  
W. G. Clark,  
M.A.  
—  
13 Feb. 1871.

and German, and to compose in one of these languages, than if he were merely able to translate the modicum of Greek which he has to do at present.

5591. (*Chairman.*) Is there any other matter upon

which you can furnish the Commission with any information?—I think that the questions which the Commissioners have asked me have exhausted all the points upon which I wished to give evidence.

The witness withdrew.

Adjourned to to-morrow at half-past 11 o'clock.

No. 6, Old Palace Yard, Westminster, Tuesday, 14th February 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

The Rev. ROBERT PHELPS, D.D., examined.

Rev. R.  
Phelps, D.D.  
—  
14 Feb. 1871.

5592. (*Chairman.*) You are master of Sidney Sussex College, Cambridge?—I am.

5593. You have already, I think, been so good as to furnish the Secretary of this Commission with a statement explaining what has been done in your college for the promotion of scientific instruction?—Yes.

5594. I gather from that letter that a fellowship has already been given in your college for distinction in natural science?—Yes.

5595. And if your college numbered among its men any that distinguish themselves from time to time in natural science, are you of opinion that the college would be disposed to recognise such?—Undoubtedly.

5596. The college, I believe, has also made arrangements for instruction in those subjects by mutual arrangements with other colleges?—We have already made arrangements of that kind. We have in Sidney Sussex College a distinguished Teacher of Chemistry and Botany, and we have built a chemical laboratory.

5597. Is it accessible to students who are not of your own college?—Yes. Our teacher of chemistry would receive pupils from any college.

5598. Are the chemical lecturer's classes attended by any considerable number of students?—Not at present. The system has scarcely had time to develop itself.

5599. Do you think it is generally known that eminence in those subjects would be recognised by your college?—It must be known, because it is advertised every year.

5600. Have you given any scholarships to encourage the study of the natural sciences?—Yes, and we advertise such every year.

5601. Has the chemical lecturer been in consultation in any way with the University Professor of Chemistry?—I should think he is perfectly well known to him.

5602. But the character of his lectures is not arranged with any reference to the lectures of the professor of chemistry?—I should think that it is. They are elementary lectures, of course.

5603. I presume that they would be rather preparatory for those who wished subsequently to attend the lectures of the professor?—We should expect that the students at our own college who require elementary instruction would avail themselves of our teacher. But, of course, the professor's lectures are open to them also.

5604. Are you of opinion that additional funds are required by the University for the promotion of the natural sciences?—It is, I have no doubt, desirable that the University should have all the funds it can honestly obtain.

5605. But is there any urgent requirement for additional funds?—Additional funds are desirable, but I do not know that there is any very urgent requirement.

5606. We have been told that the salaries of many of the professors are inadequate, that assistants are required, and that further sums are required for museums and laboratories. Do you agree with that opinion?—My notion of the professoriate is, perhaps, somewhat different from that of many persons; I hold that the function of a professor should not be in the main teaching, or, perhaps, not necessarily teaching at all. I think that he should be resident in the University as a national representative of his department of science, and that he should have an ample income and leisure for the prosecution of that department. I think that the teaching of, at any rate, the elementary parts of science might well be undertaken by the colleges.

5607. And that the professors should be mainly employed in original research?—I think so. I think it is lamentable to see our professor of chemistry, for instance, so absorbed as he really is in laborious elementary lectures.

5608. Would you wish to see him entirely exempted from being called upon to deliver lectures?—I do not know that I should go so far as that, for Professor Liveing is a most accomplished lecturer. But you will agree with me, I daresay, that the faculty and power of exposition, of such exposition at least as would interest a large assembly, may not and does not always belong to a person who is eminently calculated for the prosecution of original research in science; and this latter I regard as by far the more important function of a University Professor.

5609. Does the professor of chemistry deliver lectures which could be designated as elementary in their character?—I think he does; a part of his instruction is quite an elementary course.

5610. But it has been generally looked upon at Cambridge, has it not, that the professor's lectures should be devoted to the higher branches of the subjects which they study?—I think it ought to be (because, in my opinion, a professor's time should be devoted to to higher and more valuable work), but I do not know that it is so, especially in those new subjects.

5611. It has been so, has it not, with regard to special mathematical professors?—It has, certainly, because mathematics has been recognised as a collegiate subject, and the teaching has been very good and ample in the colleges, and the professors have taken particular branches of the subjects upon which to throw the weight of their authority.

5612. In proportion as more provision is made for teaching those new subjects in the colleges themselves, they might probably expect that those professors would devote themselves to the higher and more advanced parts of the subjects?—I should think so.

5613. Are you of opinion that the salaries at present provided for the professors are adequate for them?—Not at all.



5614. How would you propose that means should be provided for improving their position?—That is a difficult question, and one which I do not profess to have solved. But the University is a corporation, and it has power to tax its members. I am a member of the University, and I am quite ready to be taxed as an individual member of the University to any extent that may be thought proper.

5615. You are no doubt aware that proposals have been made for taxing the colleges for University purposes?—I am quite aware of it.

5616. We should be obliged to you if you would state your views upon that point?—The University is one corporation, and my college is another. If the University were poor, and my college were rich, which is not the case at all, I should deny entirely the justice of taking from the funds of my college to enrich the funds of the University. That would not be my view at all. It may be done, and probably will be done, but I do not agree to the dictum that "might" is "right."

5617. Do you object to it upon principle?—Yes. But I also object to it on the grounds that the funds of colleges are honestly administered in the fulfilment of the trusts for which they were given; and, moreover, that those funds are actually employed so as to be quite as useful as, or more useful, in the promotion of science and learning, than they would be if transferred to the University.

5618. One reason that has been assigned in favour of the proposal of taxing the colleges is to the effect that there are certain subjects which can be better taught by the University than by the colleges, and that it is not inconsistent, therefore, with the original design of the colleges that they should contribute a portion of their funds for the prosecution of those sciences?—The colleges would be contributing their share if their members were taxed equally with non-collegiate members of the University for the purpose of University teaching, such teaching being open to all.

5619. Would you tax all the members alike, resident and non-resident?—That has been the rule hitherto. It might, however, possibly be thought more just to impose a smaller tax on present than on future members, seeing that these are to derive the greater benefit.

5620. If that taxation were carried to any great extent, would it not have a tendency to discourage persons not intending to reside in the University from keeping their names on the University books?—Tolerance of taxation has, no doubt, its limits. But a small tax upon so large a number of members would produce a large sum.

5621. There is a tax at present for University purposes, is there not?—Yes; there is a tax of 17s. per annum.

5622. Has that amount been lately raised?—A short time ago it was raised from 12s. to 17s. This tax was at first a library tax of 12s. a year on every member of the University; 5s. was added to it in 1866, and it was then considered as a contribution to the University chest for general purposes. Since that time, the colleges have relieved the chest of certain heavy local rates by throwing these on college property in the town of Cambridge, so that the whole amount of the poll tax of 17s. is applicable to purely University purposes, and has at once enabled the University to increase the stipends of several of the Professors. If this tax were raised to 1*l.*, it would produce a considerable sum, and I do not see that any member of the University ought to object to paying 1*l.* a year for his membership. Besides, the University has other resources both of property and fees for matriculation and degrees.

5623. How many members of the University are there, do you know?—That I could not say exactly.

5624. And, I presume, you do not know what amount a tax of 1*l.* upon every member would produce?—I do not know with absolute accuracy, but it could not be far short of 10,000*l.* a year.

5625. Have you any other suggestion to make as to the means of raising funds for University purposes?—

If I may be allowed, I will venture to make one suggestion, namely, that if such contribution is agreed upon or levied from the colleges, I think it would be better to base it upon the actual dividends, that is to say, the actual amount divided between the master and fellows of colleges, than upon the basis of including all kinds of stipends and salaries to officials in the colleges, for this reason, that the basis of fellowship would form a tolerably uniform mode of taxation; but the payment to college officers and other payments vary very much in different colleges. The same amount might be raised, of course, whatever the basis is. Three per cent. has been proposed and five per cent.; but then it was proposed that that should be raised on what has been called the distributable revenue, and that distributable revenue was to include the payments to scholars and salaries to officers, and all sorts of things. In my opinion it would be much better to base it upon the amount divided to the master and fellows, what is called the dividends, and that that should be the basis upon which the per-centage should be reckoned. I object to it altogether as wrong and unjust, but I think that would be a more simple and convenient basis for such a tax than the other.

5626. Are the fellowships in your college poorer than the average of the University fellowships?—I do not exactly know what they are in most colleges, but ours may be called from 240*l.* to 250*l.* a year, and all our fellowships are equal. Formerly we had two, the nomination to which was vested in Tiverton School, and one to which the Fishmongers Company nominated. These, however, are now open, and, together with the six foundation fellowships, make nine, all alike equal. The master has two dividends. Then both the master and the dean, and the prælector and other officers have also stipends, but those have been regulated under the statutes, and I believe that all those official stipends vary very much in different colleges, whereas the dividends are tolerably uniform; and also the dividends are sure to form a tolerably accurate comparative estimate of the disposable means of the colleges. I think that that would get rid of a good deal of the kind of objection that some persons would feel to the inquisitorial character of the inquiry into the management and distribution of the funds of colleges.

5627. Have you ever considered whether if contributions were levied from the colleges, a heavier per-centage might be placed upon the fellowships held by non-resident fellows?—That is rather a delicate and somewhat difficult question. In the case of my own college I consider that the dividends given to the present four non-resident fellows are very usefully employed. For instance, in one case it goes to the augmentation of the scanty stipend of a very laborious colonial bishop; in another to that of an equally laborious London clergyman; in a third case to a hard-working schoolmaster; and in the fourth to the support of a medical student; so that I think they are not ill-bestowed. At the same time these gentlemen do forfeit certain benefits by non-residence. A resident fellow has college rooms and a small allowance per diem as a resident fellow, so that a resident fellow does get certain emoluments which a non-resident fellow does not get. It is, however, from the point of view of those who contemplate this mode of obtaining funds, not unnatural to consider whether non-residents ought not to contribute more, but looking at the emoluments to individual fellows in my college, they can scarcely be said to be so large as to admit of diminution, even were there no question of the justice of such requisitions.

5628. (Sir J. P. Kay-Shuttleworth.) There are two objects which are generally considered to be accomplished by fellowships. First, they are given as prizes for a successful career in the colleges; and then they are often united with the function of teaching?—Yes, it may perhaps be so considered. But, in reality, colleges make no such classification of fellows. Any one of the fellows is liable to be elected into an office which would imply the function of teaching,

Rev. B.  
Phelps, D.D.  
14 Feb. 1871.



Rev. R.  
Phelps, D.D.  
14 Feb. 1871.

and a fellow will often remain in residence on the chance of a vacancy in some such office, employing himself in private study or private tuition. Apparently, however, and perhaps practically, two such objects may be said to be accomplished.

5629. As respects the former of those objects have you ever conceived that there could be any limitation of time in the holding of a fellowship consistently with offering a sufficient reward for a successful career in the University studies?—I think it is possible that it might be so; it has been adopted, I believe, in some colleges, but it is not adopted by our statutes, and I hope it never will be. There would be this objection to it, I think, that in so small a number of fellows as we have, we should have less chance of securing a first-rate staff of lecturers.

5630. But if it were the rule throughout the University, what should you say?—If it were the rule throughout the University then I think that we should get an inferior class of men as teachers in the University. A terminable fellowship would not be a sufficient inducement to men of first-class merit to prepare themselves for the chance of office as tutors and lecturers.

5631. But if the condition of those fellowships which are considered prizes were somewhat of this sort, that they should terminate after a certain period unless the holders were invited by the college to enter upon the function of teaching and accepted that function, might not that be a proper rule which would not interfere with, but rather promote, the number of teachers in the colleges?—I am not prepared to say that it would not have that effect, but I am by no means clear that it would. Moreover, under the present system, we have no difficulty in obtaining the services of a sufficient number of first-rate men, and the provision of retirement on college livings secures us against the stagnation which is almost sure to be the consequence of superannuated married fellows.

5632. If, for example, a man enters into the world and does not succeed in a profession, and simply enjoys his fellowship during his life remote from the University, do you think that it is a very great additional stimulus to striving for learning in the University to know that the fellowships end in so profitless a career?—My experience does not give me sufficient data to judge of that, for I cannot tax my memory with any single case in my own college where a fellow has adopted such a career, where he has gone into the world and failed in his profession, and then simply lived upon his fellowship.

5633. We have had it in evidence that such cases have occurred in certain colleges?—I should think they are very rare. I know of only one fellow of a college who is ostensibly living on his fellowship. That one is not a member of my own college, nor can I say that he may not have been usefully engaged in literary work. My experience most decidedly is, that fellows of colleges are all that is the opposite of idle or useless men.

5634. On the other hand, supposing a fellow to have succeeded at the bar, or in any other career of a learned profession, might it not be expected that he should after a certain time relinquish his fellowship?—If his success were great he would be sure to do so. I know of no instance to the contrary. I do not think it possible that a case can be made out for interference on this ground.

5635. Having regard to the condition of celibacy, was it not originally rather a rule having reference to the internal constitution and discipline of the college than to the external life of the fellows who went into the world and were non-resident?—Yes; but practically I do not think it really does interfere with the condition of life. I scarcely know an instance of a man making the retention of his fellowship a consideration against marriage of greater force than would suggest itself to a prudent man in any other career. Occasionally a clerical fellow has to wait a few years for a living. But that, to my mind, is not a case to

be so much deprecated as that of improvident marriage.

5636. Would not a fellowship still remain a powerful incentive to study if the condition of celibacy were removed, but the period during which it was held was limited; and also if the rule by which a man might continue to hold his fellowship if he went into the Church, were done away with?—I think there are many objections to that. The making fellowships tenable only for a short period would at once seriously diminish their attractions. And for educational purposes in colleges founded, endowed, and further endowed from time to time from the earliest foundation to the present day, as those at Cambridge, exclusively for the benefit of members of the Church of England, it seems to me above all things desirable that most of the members of the teaching body should be in holy orders. As they succeed to college livings they are again succeeded by younger men, and thus a supply of vigorous teachers is kept up. If the fellows of my college were allowed to marry, they could not reside in college.

5637. I am speaking now of non-resident fellows?—I do not see any great objection to that, except that it would require an absolute distinction of fellows into the two classes, before alluded to, a distinction which has hitherto never existed, which was not contemplated by the founders, and which would certainly be attended by disadvantages.

5638. A fellowship would still remain a powerful incentive to study if those several conditions were removed?—Yes; but it would not be so strong an incentive to study as the present form of it.

5639. Have you any means of knowing how many of the men who have gone into the church after having held their fellowship for the required period of years, have accepted that profession as a means of continuing their fellowship?—I have no means of knowing that; it does not show itself at all, nor do I believe that it can be proved to obtain as a matter of fact. A man gets a fellowship and generally he has made up his mind before he goes for his fellowship that he will go into orders, or that he will not continue his fellowship. If he does not, in my college he vacates his fellowship at the end of three years; at least he used to, but at present it is not so; he need not go into orders at all.

5640. Morally speaking, seeing that men from conscientious motives frequently decline to take emoluments because they cannot subscribe the prescribed formularies, is it not to be deprecated that the choice of such a profession should be in any degree affected by the continuance of a fellowship?—A person ought to take that into consideration before he puts himself into the position; there are other walks of life that he might have chosen.

5641. Very often fellowships are acquired by men who are comparatively young, who have not had much experience of the world, and whose time may have been considerably devoted to literary, mathematical, or other studies, and not much to theological; in such circumstances, would not the question to a poor man, whether he should relinquish 300*l.* a year or not be a powerfully determining motive in his choice as to whether he should enter the Church or not?—But the condition does not exist at present I think, at least in my college; and even if such a person is so influenced to take holy orders, it does not follow that he has made a wrong choice of a profession.

5642. (*Chairman.*) I see in your statement that you have furnished us with you observe that half the number of fellows are exempt from the necessity of taking orders?—Yes, in my college, and that could always be arranged so that any individual might be relieved from the burden of the obligation.

5643. (*Sir J. P. Kay-Shuttleworth.*) But that rule does not generally prevail, I think, in the University?—That I am not prepared to say. In my own college it is so. And I am inclined to think that in most colleges, if not in all, there are lay fellowships. I do not believe that the clerical obligation is oppressive.

5644. You have mentioned, have you not, that you



would like the same amount of liberty to obtain in other colleges as that which obtains in Sidney Sussex?—I should have no objection at all. I think it is very important that no such motive should weigh unduly with any person.

5645. Supposing that such a limitation as I have described should be adopted, would not the first effect of that upon the prize fellowship be to provide for a more rapid succession, that is to say, the time being diminished more individuals would in succession enjoy the fellowship?—Yes.

5646. Would not that prove a considerable incentive to the students who resort to the University, seeing that more students would enjoy these fellowships within a limited period of years?—Perhaps so. But I don't believe the effect would be of any appreciable importance.

5647. Or on the other hand it might place at the disposal of the respective colleges money which could be applied to the maintenance of a central professoriate?—It might be, but I am not prepared to go that length. Any such diversion of funds from my college would, in my opinion, be a wrong and an evil.

5648. We have not been without suggestions to that effect. I do not mean in the precise form in which I have put it, but that there should be either a consolidation of fellowships for the foundation of professorships, or that there should be funds derived in one way or other from the possible extinction of fellowships, or a diminution of their value, or a limitation of the period during which they are held; probably you do not think that those would be wise suggestions?—I am not prepared to say that I recommend them.

5649. (*Professor Stokes.*) What do you conceive to have been the original object of the foundation of the colleges?—The original object of the foundation of my college was the education of the members for the Church undoubtedly.

5650. But there are other colleges, are there not, in which education for the Church was less exclusively looked to?—Probably so, I am not prepared to answer that question.

5651. In the education of the members of a college, whether for the Church or for any other calling in life, is it not desirable that means should be afforded for instruction in a variety of subjects?—I think so.

5652. And not merely in the stock studies of the place?—I think so certainly. The education of a clergyman cannot, in my opinion, be too liberal.

5653. If each member of a college had a cook and a kitchen of his own his food would cost a good deal more than according to the present system, in which there is a college kitchen and the men dine in hall; in the same way do you not think that in those studies which are not exactly the stock studies of the place instruction could be carried on better, and for a less expenditure of money, by the colleges combined together so as to afford the University the means of instructing in those branches of knowledge?—I think it might be done in another way; by the colleges combining one with another, and mutually receiving students in certain branches of study. I do not see any very great advantage in referring it to a central system as it were. I think teaching is much better done where a great amount of individual attention can be given than in a wholesale manner, as is necessarily of the essence of the professorial system.

5654. If besides the chief professors in the several branches there were demonstrators or assistant professors, their number to be determined by the number of students who on the average attend to those particular branches of study, would there not then be an opportunity for individual instruction?—I suppose there would, and that would be in some degree a corrective; but I do not see that that is necessary if the colleges themselves could provide such demonstrators and such means of individual instructions. And consequently it seems to me to make no case of urgency for requisitions on the colleges.

5655. But do you think that instruction of this

character could be carried on as well if the colleges were left entirely to themselves to combine in threes, or fives, or whatever it might happen, for this purpose, as if they all combined together according to a general system?—In my opinion, professors' lectures would best accomplish their high objects when delivered to classes already well prepared with elementary knowledge; and such knowledge can undoubtedly be imparted as part of the college system of instruction. In short, I should not like to change the collegiate system into a central University system for any kind of instruction whatever.

5656. Not even for what are called outlying branches?—I do not think that there can be any outlying branches belonging to general education. I am not aware what you would call an outlying branch.

5657. For instance, such a study as botany. That at present is not obligatory on a student of the University, but if he pleases to take it up he may do so?—But surely with such books as we have now, and with the very attentive curator in the botanic garden, and the professor, with the apparatus, in fact, which we already possess, nobody can have any difficulty in mastering botany. It does not seem to me that that would require a great central establishment. What I mean is this, that it does not strike me that either botany or any other science requires any financial interference with the corporate funds of colleges.

5658. The means of instruction in botany to which you have alluded are all centralised, are they not, for they do not belong to any particular college?—No, they do not, but they are accessible to every person, whether belonging to a college or not, who is a matriculated member of the University. And I am far from wishing to reject or depreciate any of the extra-collegiate advantages which we all possess in common.

5659. Then that speaks in favour, so far as it goes, of what you would call a system of centralisation?—No, I think not; I do not think it furnishes a sufficient argument to disturb the present collegiate system.

5660. But where would the disturbance be?—The disturbance would be in absorbing the college funds in order to create this central system, which I think would be bad or unjust, as well as unnecessary. I have a full appreciation of the value and dignity of the professoriate, and I should rejoice to see it richly endowed, as it deserves to be. But I cannot agree that it ought to be endowed at the expense of private corporate bodies.

5661. Are you prepared to go the length of saying that you would consider it to be bad to absorb any fraction of the college funds?—If you admit a fraction there is no knowing where it would stop. I object to the principle. I think that the colleges, as corporations, endowed with funds for special objects in trust, are fulfilling that trust, and that nothing which I ever heard would justify an interference with those funds for a central purpose. If the colleges could be shown not to be fulfilling their trust, or to be misusing those funds, that would be another thing, but I do not believe that that could be shown.

5662. Supposing such interference were to take place, whether by might or by right, according to people's notions, do you consider that the college officers in the different colleges are paid on very much the same scale, or do they vary very much from college to college?—I think they vary; ours have varied since the last Commission, in fact, under the statutes of the last Commission some have been doubled.

5663. Supposing that in the case of two colleges a fellow in the one college had 200*l.* a year as fellow, and 100*l.* a year for discharging a certain college office, and in the other college a fellow had 300*l.* a year as fellow, and a mere nominal sum for discharging the same office as in the other college, the total sum that they would receive and the work that they would do would be the same in the two cases; yet if the two colleges were to contribute to a common fund according to the sum actually divided, the sum levied from those two colleges would be different; does that appear to you to be an objection to the scheme which you propose?

*Rev. R.  
Phelps, D.D.*  
14 Feb. 1871.



Rev. R.  
Phelps, D.D.  
14 Feb. 1871.

—It does not appear to me to be any objection at all, inasmuch as I think it is less just to tax money paid for work done than it is to tax money paid in the form of a dividend to which no work is assigned.

5664. Then if such a scheme as that which you propose were carried out, it would become the interest of a college, in assigning the payments to the resident fellows, to diminish what goes under the name of dividend, and to increase what goes under the name of remuneration for offices?—It could not be so. The dividends are the same to non-resident as to resident fellows; and the stipends of college officers are fixed by statute.

5665. Is that the case in the colleges generally?—I think it is. I am not sure as to other colleges, but in ours they are fixed.

5666. (*Chairman.*) Could you furnish the Commission with information upon any other points bearing upon their inquiry?—Nothing else occurs to me.

As supplementary to the evidence which I have

The witness withdrew.

E. Frankland,  
Esq., Ph.D.,  
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EDWARD FRANKLAND, Esq., Ph.D., D.C.L., F.R.S., examined.

5667. (*Chairman.*) Will you be so good as to state to the Commission the history of the Royal College of Chemistry?—The Royal College of Chemistry was founded in the year 1845 by a number of noblemen and gentlemen for the purpose of encouraging the study of chemistry, with a view to its application to arts and manufactures. They applied to Baron Liebig, in the first instance, to supply them with a professor, and three names were suggested, namely, those of Dr. Will, Professor Fresenius, and Dr. Hofmann. Ultimately the choice fell upon Dr. Hofmann, who in the autumn of 1845 commenced his duties as the professor of the college. The college was opened in that year in a temporary laboratory, in George Street, Hanover Square; and it was transferred in the following year to the building which it at present occupies.

5668. What was the salary that Dr. Hofmann received when originally appointed?—Dr. Hofmann's salary was in the first instance 400*l.* per annum, with a prospective increase, and in addition to that he had 2*l.* per pupil for all pupils who worked an entire session, that is to say, an entire year in the college; and, moreover, he had a furnished house to live in, attached to the college.

5669. Was this 400*l.* per annum derived from the subscriptions of those who had founded the college?—It was entirely so. But I may mention that, as appears from the minutes of the council, Government assistance was contemplated at the time of the establishment of the college. It was sought in the form of a grant of land to build the college upon, but it was found that by a then recent Act of Parliament the Government had no power to make any such grant, and consequently the Council received no assistance whatever from the Government.

5670. What was the scale of fees in the college as it originally started?—I find the following in the minutes of the council, but it does not appear from this what the fee was for a student working every day in the week. The following is the scale which I find here:—"Four days a week, 10*l.* per session," a session being the half academical year of five months. "Three days a week, 8*l.* per session; two days a week, 6*l.* per session; and one day per week, 4*l.* per session."

5671. Were there two sessions in the year?—Yes; there were two sessions in the year at that time.

5672. The college was at an early date authorised, was is not, to assume the title of the Royal College of Chemistry?—It was. Permission was given by the Queen on the 19th of November 1845.

5673. But I believe it was not at that time in any way connected with the Government?—It was not.

5674. Do you know how much was expended on laboratories and fittings?—I cannot ascertain, without going minutely into the accounts—and I scarcely feel competent to do that—what was actually expended, but

given, I wish to be allowed to remark that, in my opinion, there are few if any sciences which, coming fairly within the curriculum of an university education, require appliances and apparatus beyond what a college could command. And for the studying and teaching of such sciences it must, I think, be allowed that the University already possesses unrivalled means. I allude especially to the sciences of geology and human and comparative anatomy—and I might perhaps add botany, mineralogy, zoology and chemistry. I venture to say that to enforce contributions from college funds for University purposes in connexion with such sciences as these would be, in my opinion, a wanton and unnecessary, as well as a most unjustifiable spoliation. It must be remembered that members of the University are not necessarily members of any college. And, surely, to insist on the employment of college funds for supplying non-collegiate members of the University with professors and apparatus is to adopt principles which can only be characterised as arbitrary and communistic.

there is an estimate of what was to be expended, and that amounts to 5,000*l.*, which includes the building, the purchase of the lease of the house, and the laboratory fittings.

5675. Is that the whole sum expended in building of any kind?—In building and in the internal fittings, and fixed apparatus, and probably that was not much exceeded judging from the terms of the subsequent transfer to the Government.

5676. At what date was the college transferred to the Government?—On the 7th July, 1853.

5677. Are you acquainted with the circumstances which led to the transfer?—Yes. I have before me here a letter from Dr. Lyon Playfair, which I think explains, in the shortest possible way, that transfer, and with your Grace's permission I will read it. It is addressed to the Right Hon. Lord Ashburton, "Department of Science and Art, Marlborough House, July 7th, 1853. My Lord, I am desired by the Lords of the Committee of Privy Council of Trade to reply to your Lordship's letter of the 9th of May, in which your Lordship offers on the part of the Council of the Royal College of Chemistry to recommend to its subscribers to present to the Government the lease of the premises and all the fittings and appliances, valued at 3,000*l.* The conditions attached to this proposed transfer, my Lords understand to be (1) that the Government should take an assignment of the lease of the college buildings, and pay the rental of the premises, viz., 180*l.* per annum; (2) that the Government pay a sum of 350*l.* to the Council of the college in the name of expenses which cannot be met in the usual way by the subscription of members in the event of the offer made by the Council being accepted by Government and ratified by the members of the college; (3) that this sum of 350*l.* should be considered as a loan, and be repaid out of any sums which may hereafter accrue from the possible sale of the lease, fixtures, and apparatus of the college, it being understood that any further sum of money arising from such sale should be devoted, as the Government may deem fit, to the promotion of practical chemistry. My Lords have submitted these conditions to the Lords Commissioners of Her Majesty's Treasury as being highly liberal on the part of the Royal College of Chemistry, and very advantageous to the public, and the sanction of the Treasury has been obtained for the acceptance of the offer of the Council on the above terms. I have the honour to be your Lordship's obedient servant, Lyon Playfair, Secretary." Then follows this resolution "That the following notice be advertised and communicated to each member of the Royal College of Chemistry, according to the laws of the institution." "Royal College of Chemistry. Notice is hereby given that the general annual meet-



"ing for the ordinary business will take place at the apartments of the college, in Oxford Street, on Tuesday, the 26th of July, and that the said meeting will be special for the consideration of a proposal for amalgamating the Royal College of Chemistry with the Metropolitan School of Science, and for assigning the lease of the college buildings to the Government. The chair will be taken at 2 o'clock precisely. (Signed) Ashburton." That is the last minute in the book. The name of the Metropolitan School of Science appears repeatedly in the minute book at that time.

5678. That is practically the same institution, is it not, as what is now called the Royal School of Mines?—Exactly.

5679. Was it not contemplated at the time of the transfer that the College of Chemistry should form part of that institution, or should be closely connected with it?—It was. In fact, it was substituted, as it were, for the chemical department of the School of Mines, which had previously been presided over by Dr. Lyon Playfair and Mr. Richard Phillips.

5680. I believe Dr. Hofmann continued for some time after the transfer to act as professor?—Dr. Hofmann continued to occupy the chair until the 30th of June 1865, at which time I succeeded him.

5681. Can you furnish the commission with a schedule of the number of students who were instructed in the laboratory of the college before this transfer to the Government?—I can, and it is as follows :—

*E. Frankland,  
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14 Feb. 1871.

SCHEDULE of the NUMBER of STUDENTS working in the LABORATORIES, during each session, commencing with the year 1845 to the time when the College passed into the hands of Government, viz., in the year 1853.

Sessions.	1845-46.	1846-47.	1847-48.	1848-49.	1849-50.	1850-51.	1851-52.	1852-53.	Total.
Winter session -	26	46	43	47	48	37	35	53	335
Summer session -	37	44	54	53	47	53	37	44	319

These schedules which I have prepared for the Commission require a little explanation. The first schedule shows the number of students actually occupied in the laboratories in practical work during the winter and summer sessions of various years from 1845 to 1853. Those numbers do not show the number of students passing through the college, they merely show the numbers engaged in the laboratories. Of course many

students who were engaged in the winter session were also engaged in the following summer session and will be numbered twice over in that table. This is the case also in the next schedule which shows the number of students working in the laboratories of the Royal College of Chemistry, after the college passed into the hands of the Government, and it is as follows :—

SCHEDULE of the NUMBER of STUDENTS working in the LABORATORIES of the ROYAL COLLEGE of CHEMISTRY, after the College passed into the hands of Government, viz., from 1852 to 1870.

Sessions.	1853-54.	1854-55.	1855-56.	1856-57.	1857-58.	1858-59.	1859-60.	1860-61.	1861-62.	1862-63.	1863-64.	1864-65.	1865-66.	1866-67.	1867-68.	1868-69.	1869-70.
Winter -	{ 23 39 }	51	54	55	39	54	40	34	39	55	47	39	38	39	54	45	55
Spring -	42	32	31	44	33	41	50	55	41	39	45	50	39	41	54	41	41
Summer -	32	31	31	54	27	38	55	36	39	42	46	40	38	40	37	45	38

In this schedule it will be seen that the year is divided into three sessions or terms, as is the case at the present time. The next schedule is one of the number of students who have received their chemical education, either wholly or partly, in the laboratories of the Royal College of Chemistry during the time when the

college was a private institution. The totals in this schedule, at the foot of each column, represent the actual number of students who passed through the college and left the laboratory in each academical year :—

SCHEDULE of the NUMBER of STUDENTS who have received their chemical education either wholly or partly in the LABORATORIES of the ROYAL COLLEGE of CHEMISTRY during the time the College was a private institution, viz., from 1845 to 1853.

Sessions.	1845-46.	1846-47.	1847-48.	1848-49.	1849-50.	1850-51.	1851-52.	1852-53.	Total.
Winter session -	26	25	26	24	23	21	26	33	204
Summer session -	23	27	22	27	15	11	16	15	156
	49	52	48	51	38	32	42	48	360

5682. In the third schedule are those who are stated to have received their education in the summer session different students from those who are stated to have been educated in the winter session?—Yes; they are different students. They are students who left the laboratory in those particular sessions; who had passed through the course, or at all events, passed through as far as they intended. The totals represent so many men who were turned out of the College of Chemistry

more or less completely trained in each year; and you will find that the average per year in that schedule is 45. The next schedule shows the number of students who have received their chemical education, either wholly or partly, in the laboratories of the Royal College of Chemistry since the college passed into the hands of Government, viz., from the year 1853 to the end of 1870, and the average per year, in this case, will be found to be 38. The schedule is as follows :—



E. Frankland,  
Esq., Ph.D.,  
D.C.L., F.R.S.

14 Feb. 1871.

SCHEDULE of the NUMBER of STUDENTS who have received their Chemical Education, either wholly or partly, in the LABORATORIES of the ROYAL COLLEGE of CHEMISTRY since the College passed into the hands of Government, viz., from the year 1853 to the end of 1870.

Sessions.	1853-54.	1854-55.	1855-56.	1856-57.	1857-58.	1858-59.	1859-60.	1860-61.	1861-62.	1862-63.	1863-64.	1864-65.	1865-66.	1866-67.	1867-68.	1868-69.	1869-70.
Winter	36	12	11	25	20	18	23	22	25	25	11	18	21	21	21	25	35
Spring	12	11	11	7	11	8	7	11	7	9	11	6	9	7	8	14	4
Summer	5	10	11	6	7	6	3	6	2	6	4	9	6	6	8	4	1
	53	33	30	38	35	32	33	30	34	40	49	33	36	44	37	43	41
Total																	

Total - - - - - 648

This would indicate that a smaller average number of men were turned out yearly, after the college passed into the hands of the Government than was the case before, and no doubt that is so; but this result comes about in this way. In the first years after the establishment of the college a greater number of students entered for very short periods, say, a month, or two months, or three months perhaps; but the time devoted to study increased with the progress of the college, and consequently the 38 men per year who have been turned out, on an average, since the college was transferred to Government represent men that were much better trained than many of those who were turned out in the first years. I have also prepared another schedule, which contains the titles of the original researches that have been carried out in the laboratory of the Royal College of Chemistry since the year 1845. The memoirs describing these researches have been published either in the Philosophical Transactions, the Journal of the Chemical Society, or elsewhere.

SCHEDULE of ORIGINAL RESEARCHES executed in the LABORATORY of the ROYAL COLLEGE of CHEMISTRY since the year 1845.

1. Researches on Cumarine, by H. Bleibtreu.
2. On the compounds of phosphoric acid with analine, by Edward Chambers Nicholson.
3. Analysis of the thermal waters of Bath, by George Merck and Robert Galloway.
4. Analysis of a Peruvian alloy, by Henry How.
5. Analysis of Bohemian glass, as found in combustion tubes employed in organic analysis, by Thomas Rowney.
6. On caffeine, by E. C. Nicholson.
7. Analysis of the ashes of the orange tree, by Thomas H. Rowney and Henry How.
8. On some of the products of oxidation of Cumol, by F. A. Abel.
9. On the action of nitric acid on cymol, by Henry Noad.
10. On the products of the decomposition of cuminate of ammonia by heat, by Frederick Field.
11. On cochineal, by Warren De la Rue.
12. On cumidine, a new organic base, by E. C. Nicholson.
13. Analysis of the deep well-water in Trafalgar Square, by Frederick Abel and Thomas Rowney.
14. Analysis of Thames water, by Geo. F. Clark.
15. Researches on coal naphtha, by Charles B. Mansfield.
16. Analysis of the Cheltenham waters, by Frederick Abel and Thomas Rowney.
17. Researches on aniline, by A. W. Hofmann.
18. Researches on the volatile bases, by A. W. Hofmann.
19. On the action of iodine on aniline, by A. W. Hofmann.
20. Researches on the amyl series, by H. Medlock.
21. On the composition of mesitolol and some of its derivatives, by Dr. Hofmann.
22. On nitroresitine, a new organic base, by G. Maule.
23. On the action of baryta on salicylic ether, by G. Balz.
24. Analysis of the mineral constituents of the flax plant, by J. E. Mayer and J. S. Brazier.
25. Analysis of plate glass, by J. E. Mayer and J. S. Brazier.
26. Analysis of Thames water, by Edward T. Bennett.
27. Researches on strychnine, by E. C. Nicholson and F. A. Abel.
28. Researches on the volatile organic bases, Nos. iv., v., vi., and vii., by Dr. Hofmann.
29. Researches regarding the molecular constitution of the organic bases, by Dr. Hofmann.
30. On the passage of cuminic acid through the system, by Dr. Hofmann.
31. On propylene, a new hydrocarbon, by Captain Reynolds.
32. On the action of heat upon valeric acid, with some remarks upon the formulæ of the alcohol radicals, by Dr. Hofmann.
33. On the action of chloride of cyanogen upon toluidine, by W. Wilson.
34. On bichromate of ammonia and some of its soluble salts, by Henry R. Richmond and J. S. Abel.
35. Contributions towards the history of caproic and ænanthylic acids, by J. S. Brazier and G. Gossleth.
36. On propione, the ketone of propionic acid, by Reginald T. Morley.
37. On the selenocyanides, by W. Crookes.
38. Observations on the department of diplatosamine with cyanogen, by G. B. Buckton.
39. Examination of an ore of Cinnabar from New Almaden, California, by Adam Bealey, M.A.
40. Contributions to the history of aniline, azobenzole, and benzidine, by A. W. Hofmann.
41. On the action of sulphuric acid upon anisic and salicylic acids, by A. W. Hofmann.
42. Analysis of a sediment deposited from the River Nile, in Lower Egypt, by Matthew W. Johnson.
43. On a simple aspirator, by the same.
44. On some of the metamorphoses of naphthalamine, by A. W. Hofmann.
45. On dibenzoylamide, a new derivative of oil of bitter almonds, by Joshua H. Robson.
46. On phosphoretted ureas, by A. W. Hofmann.
47. On the molecular constitution of the organic bases, second memoir, by A. W. Hofmann.
48. Chemical report on the supply of water to the metropolis, by Graham, Hofmann, and Miller.
49. Contributions towards the history of the monamines, by A. W. Hofmann.
50. Report upon the alleged adulteration of pale ales by strychnine, by Hofmann and Graham.
51. Report upon original gravities, by Hofmann, Graham, and Redwood.
52. Researches on the sulphocyanide and cyanate of naphthyl, by A. W. Hofmann.
53. On the qualitative separation of arsenic, tin, and antimony, by Geo. F. Ansell.
54. On the diatomic ammonias, by A. W. Hofmann.
55. On the detection of tin, antimony, and arsenic, by Charles L. Bloxam.
56. Action of nitrous acid upon nitrophenylenediamine, by A. W. Hofmann.
57. Note on the preparation of carbonate of amyl, by Charles A. Bruce.
58. Remarks on anomalous vapour densities, by A. W. Hofmann.
59. On the action of ammonia upon binoxy-sulphocarbonate of amyl, by Matthew W. Johnson.
60. On the use of gas as a fuel in organic analysis, by Dr. Hofmann.
61. Analysis of the ash of lemon juice, by Henry M. Witt.
62. On sulphamidobenzamine, by A. W. Hofmann.
63. On the existence of trimethylamine in the brine of salted herrings, by Gresham Henry Winkles.
64. Experiments in the methyl and methylene series, by A. W. Hofmann.
65. On the action of iodide of ethyl on toluidine, by Reginald T. Morley, and John S. Abel.
66. On the action of cyanide of ethyl on urea, by A. W. Hofmann.
67. On caprylamine, by William S. Squire.
68. Chemical analysis of the mineral waters of Harrogate, by A. W. Hofmann.
69. Report on the supply of spirit of wine, free from duty for use in the arts and manufactures, by Graham, Hofmann, and Redwood.



70. On the diagnosis of diamines, by A. W. Hofmann.
71. On some new colouring matters, derivatives of dinitrobenzole, dinitronaphthaline, by A. H. Church and W. H. Perkin.
72. On the separation of the ethyl bases, by A. W. Hofmann.
73. Action of chloride of cyanogen on naphthalamine, by W. H. Perkin.
74. On insolonic acid, by A. W. Hofmann.
75. On the discovery of Mauve, by W. H. Perkin.
76. Researches on a new class of alcohols, by A. W. Hofmann, and A. Cahours.
77. Researches on the phosphorus bases, by A. W. Hofmann, and A. Cahours.
78. On the action of chloracetic ether on triethylamine triethylphosphine, by A. W. Hofmann.
79. Researches upon the action of sulphuric acid upon the amides and nitriles, by A. W. Hofmann, and G. B. Buckton.
80. Contributions to the history of the phosphorus bases, (3 memoirs), A. W. Hofmann.
81. Contributions towards the history of thialdine, by A. W. Hofmann.
82. On nitrophenol.  
On a new mode of forming triethylamine.  
On a crystalline compound of hydriodic acid, and phosphoretted hydrogen, by A. W. Hofmann.
83. On the action of sulphuric acid on anisic acid by Louis Zervas.
84. Researches on colouring matters derived from coal-tar, by A. W. Hofmann.
85. Analysis of the Tunbridge Wells water, by J. Thomson.
86. On aniline-blue, by A. W. Hofmann.
87. On the use of gas as fuel in organic analysis, by A. W. Hofmann.
88. On diphenylamine, by A. W. Hofmann.
89. On ammonia and its derivatives, by A. W. Hofmann.
90. On phenyltolylamine, by A. W. Hofmann.
91. On the colouring matters produced from aniline, by A. W. Hofmann.
92. On paraniline, by A. W. Hofmann.
93. On the secondary products formed in the manufacture of aniline, by A. W. Hofmann.
94. On hydrobenzol, a new compound isomeric with benzidine, by A. W. Hofmann.
95. Miscellaneous observations, by A. W. Hofmann.
96. Analysis of the saline water of Christian Malford, by A. W. Hofmann.
97. On the changes of gutta percha under tropical influences, by A. W. Hofmann.
98. Note on the action of chloride of ethyl on ammonia, by C. E. Groves.
99. On azobenzol and benzidine, by W. P. Hofmann.
100. On the bromide of carbon, by A. C. W. Lennox.
101. On formamide, by A. W. Hofmann.
102. Contributions to the history of the Tolyl series, by Eugene Sell.
103. On isomeric diamines, by A. W. Hofmann.
104. On some compounds of the amido acids with cyanogen, by Griess and Leibius.
105. Researches on the composition of the blue derivatives of the tertiary monamines derived from cinchonine, by A. W. Hofmann.
106. On the action of dibromide of ethylene on pyridine, by John Davidson.
107. On the action of iodide of methyl on ammonia, by A. W. Hofmann.
108. Transformation of aniline into benzoic acid, by A. W. Hofmann.
109. On sparteine, by E. J. Mills.
110. New volatile organic acids of the mountain ash berry, by A. W. Hofmann.
111. An investigation of several varieties of copper wire for the use of the Transatlantic cable at the suggestion of Professor W. Thompson, by A. W. Hofmann.
112. Notice of researches on the sulphocyanide and cyanate of naphthyl, by Vincent Hall.
113. Contributions towards the history of the colouring matters derived from aniline, by A. W. Hofmann.
114. Researches on a new class of organic bases (nitroso-derivatives) from nitronaphthaline, by Charles S. Wood.
115. Report presented to the Metropolitan Board of Works "on the deodorization of sewage," by A. W. Hofmann and E. Frankland.
116. Experiments on the composition of the coal gas delivered by some of the London companies, by A. W. Hofmann, for the Commission appointed to consider the subject of lighting picture galleries by gas.
117. An experimental inquiry into the processes proposed for the preservation of the stone employed in building the Houses of Parliament, by A. W. Hofmann and E. Frankland.
118. On the constitution of allophane, by A. B. Northcote.
119. Contributions towards the history of the colouring matters derived from coal-tar, by A. W. Hofmann.
120. On the brine springs of Cheshire, by A. B. Northcote.
121. Monthly analysis of the waters supplied to the metropolis by the water companies from 1865 to the present time; by A. W. Hofmann and E. Frankland.
122. On a new form of aspirator, by Herbert McLeod.
123. On the analysis of potable waters, by E. Frankland.
124. On the analysis of potable waters, by E. Frankland and Henry E. Armstrong.
125. On a simple apparatus for determining the gases incident to water analysis, by E. Frankland.
126. On the isomeric forms of valeric acid, by A. Pedler.
127. On the estimation of nitrogen, by Dumas'; method by W. Thorp.
128. On the successive action of sodium and iodide of ethyl upon acetic ether, by E. Frankland and B. F. Duppa.
129. Researches on gaseous spectra in relation to the physical constitution of the sun, stars, and nebulae, by E. Frankland and J. Norman Lockyer.
130. On fungoid growths in potable and other waters, by E. Frankland.
131. On acetylene, by Herbert McLeod.
132. On the estimation of sulphur in coal gas, by W. Valentin.
133. Apparatus for estimation of gases in waters, by Herbert McLeod.
134. New form of apparatus for gas analysis, by Herbert McLeod.
135. On the estimation of carbon in steel, by W. D. Hermann.
136. On the presence of arsenic in the fuel, air, and sewage of London, by E. Frankland.
137. On supersaturated solutions, by Dr. S. Coppet.
138. On the composition of potable waters for the supply of the metropolis from the Cumberland and Westmoreland Lakes, North Wales, and the Thames basin, by E. Frankland and W. Odling.
139. Researches on the comparative durability of different inks used for transcribing important documents in various departments of Her Majesty's service, by E. Frankland.
140. On the formation and properties of cymidine, by the Rev. J. Barlow.

E. Frankland,  
Esq., Ph.D.,  
D.C.L., F.R.S.

14 Feb. 1871.

I would point out amongst these researches the celebrated ones of Dr. Hofmann on the ammonia bases which have exercised a most important influence upon the progress of the science, and have rendered that branch of chemistry quite a model of completeness; and also the researches of Mr. Perkin, upon aniline, which resulted in the discovery of the now celebrated aniline or coal-tar colours. It may be stated that both the researches of Dr. Hofmann and those of Mr. Perkin, at the College of Chemistry, led to this discovery of the processes for manufacturing aniline colours from the products of the destructive distillation of coal, for Dr. Hofmann's researches on the artificial organic bases taught the method of making such substances from benzol which is contained in coal tar, whilst Mr. Perkin, who was the discoverer of the first aniline colour, was a pupil at the College of Chemistry at the time he made the discovery.

5683. Have you also prepared another list of students who have distinguished themselves?—Yes, and I now put it in.

STUDENTS of the ROYAL COLLEGE of CHEMISTRY whose subsequent positions are known.

1. J. C. Roll, pharmaceutical chemist.
2. Henry How, Professor of Chemistry in Nova Scotia University.
3. Thos. Rowney, Professor of Chemistry in Queen's College, Galway.
4. John Maltland, pharmaceutical chemist.
5. Robert Galloway, Professor of Practical and Technical Chemistry in the Royal College of Science, Dublin.
6. Charles S. Bloxam, Professor of Chemistry at King's College, London, and in the Military Academy, at Woolwich.
7. F. A. Abel, F.R.S., Director of the Chemical Establishment of the War Department.



*E. Frankland,  
Esq., Ph.D.,  
D.C.L., F.R.S.*

14 Feb. 1871.

8. Ed. C. Nicholson, inventor and manufacturer of magenta.
9. H. Y. Taylor, pharmaceutical chemist.
10. John Nesbitt, late director of the Agricultural College, Kennington.
11. Dr. Swain, physician (formerly in practice in London).
12. John Field, pharmaceutical chemist.
13. Thos. Hall, B.A., late teacher of chemistry in the City of London School.
14. J. Alex. Spencer, manufacturer of photographic materials.
15. Warren de la Rue, F.R.S., late president of the Chemical Society.
16. Dr. Rt. Barnes, officer of health in London.
17. Wm. Chisholm, manufacturing chemist (deceased).
18. Geo. Sturge, merchant.
19. Geo. Simpson, manufacturer of magenta and other aniline colours.
20. Josh. Da Camara, merchant.
21. N. A. Meeson, M.D., formerly lecturer on chemistry at a provincial institution (deceased).
22. Chs. Mansfield, author of a process for extracting benzol from coal tar (deceased).
23. — Pincher, formerly pharmaceutical chemist, now clergyman and schoolmaster.
24. Lewis Boot, pharmaceutical chemist.
25. Fred. Field, F.R.S., manufacturer of stearic and paraffin candles and afterwards of aniline colours, formerly Lecturer on Chemistry at St. Mary's Hospital and the London Institution.
26. Chs. Button, manufacturing chemist (deceased).
27. J. R. Rogers, pharmaceutical chemist.
28. Geo. Merck, manufacturer of alkaloids in Germany.
29. Julian Hill, engineer.
30. Fr. Perrins, pharmaceutical chemist (deceased).
31. Bransby B. Cooper, F.R.S., Surgeon at Guy's Hospital (deceased).
32. Hy. Noad, Ph.D., F.R.S., Lecturer on Chemistry in St. George's Medical School.
33. B. Cooper, manager of silk dyeworks.
34. Geo. Bulpitt, amateur chemist.
35. John Mitchell, author of "Metallurgy" and other works (deceased).
36. Arthur Christie, brewer.
37. Js. Patient, surgeon.
38. Sharp C. Heywood, varnish manufacturer.
39. Rt. Epps, surgeon.
40. Wm. Thoms, manufacturing chemist (deceased)
41. Gavin Hardie, amateur chemist.
42. Hy. Abel Smith, banker, Nottingham.
43. Hy. Condry, chemical manufacturer, Battersea.
44. R. Brigham Shepherd, late chemist to Cobalt Works (deceased).
45. Rt. Richardson, manufacturing chemist.
46. Fr. Manning, late Chemist to the Mint at Hong Kong.
47. Capt. Reynolds, author of an investigation on Propylene, Colonel commanding at Manchester.
48. Morris Scanlan, manufacturing chemist.
49. Rd. Medwin Hands, manufacturer of aniline colours.
50. Js. Corbett, engineer.
51. Howard Bankart, metallurgist and mining engineer.
52. Dr. Sieveking, physician at St. Mary's Hospital.
53. J. S. Abel, manager of silver works, Chili.
54. John Parkin, physician.
55. Geo. Baly, manufacturing chemist.
56. Wm. Childs, pharmaceutical chemist.
57. Hy. Ths. Lowe, manufacturing chemist.
58. Matthew Johnson, late assistant to Dr. Stenhouse, Author of several papers in Chemical Society's Journal (deceased).
59. Wm. Bennett, amateur chemist.
60. Robt. Woolaston, M.D., physician.
61. Walter Freeman, formerly Lecturer at Brighton College.
62. Nl. G. Weaver, manufacturing chemist.
63. Henry Medlock, discoverer of magenta.
64. John Mayer, Inspector General of Hospitals (late Madras Presidency).
65. John Smith Brazier, Professor of chemistry in the University of Aberdeen.
66. Geo. Maule, manufacturer of aniline colours.
67. John M. Ashley, for some time lecturer on chemistry at a school of medicine, now clergyman.
68. Alf. Bennett, amateur chemist.
69. Capt. Rushout (now Lord Northwick).
70. Robt. Grouse, surgeon.
71. Wm. Odling, F.R.S., Fullerman Professor of chemistry in the Royal Institution.
72. John Spiller, manufacturer of aniline colours.
73. Rowlandson Cartmell, chemist to Messrs. Salt & Co.'s brewery, Burton.
74. John Nidd Smith, marine engineer.
75. John Longmaid, manufacturing and metallurgic chemist.
76. Js. Benj. Barns, pharmaceutical chemist.
77. Js. Easton, engineer.
78. James Kayess, silk dyer.
79. John Browning, manufacturer of physical apparatus.
80. Dr. Stewart, physician at Middlesex Hospital.
81. Wm. Crookes, F.R.S., discoverer of thallium, editor of the "Chemical News."
82. Wm. Thos. Doyne, civil engineer.
83. Grant S. Dalrymple, engineer.
84. Geo. Buckton, F.R.S., amateur chemist; author of many chemical papers in the Philosophical Transactions and elsewhere.
85. Wm. J. Dent, assistant-chemist to the War Department.
86. Lieut. Hore, Capt. R.N. naval attaché in Paris.
87. Geo. Gossleth, chemical manufacturer.
88. Dr. Smith, Professor of Chemistry, University of Sydney.
89. Fr. Wm. Pavy, physician.
90. Edwin O. Brown, assistant-chemist to the War Department.
91. Edmund Joynson, paper maker (deceased).
92. Hy. Richmond, author of a paper, with J. S. Abel on Bichromate of Ammonium, Governor of the Province of Taranaki, New Zealand.
93. Reginald Morley, for some time assistant to Dr. Hofmann at R.C.C. (deceased).
94. Fr. Paget, engineer.
95. Capt. Gall, Indian army.
96. Capt. Eliot, Indian army.
97. Chas. F. Burnard, manure manufacturer.
98. Capt. Ludlow, Indian army.
99. Miller Masters, late assistant to Messrs. Lawes and Gilbert.
100. Napoleon Price, perfumer.
101. Adam Bealy, M.A., physician.
102. James Riley, analytical chemist, Leeds, formerly chemist to the Dowlais ironworks.
103. Arth. Ackermann, colour manufacturer.
104. Chas. Tookey, late assayer to the Mint at Hong Kong.
105. Ths. Boycott, physician (late Indian service).
106. — Owen, chemical manufacturer.
107. A. B. Northcote, late Chemical Tutor, Oxford.
108. Arthur Herbert Church, Professor of Chemistry, Royal Agricultural College, Cirencester.
109. Geo. T. Ansell, late officer in H. M. Mint.
110. G. Liveing, Professor of Chemistry, Cambridge.
111. — Grettan, partner in Bass & Co.'s brewery, Burton.
112. — Poyser, managing partner in Allsopp's brewery.
113. D. H. Bottinger, late manager in ditto.
114. Hy. Witt, joint author with Dr. Hoffman of Investigations on London Sewage (deceased).
115. Wm. Spiller, manufacturer of aniline dyes.
116. Dr. Wadham, physician.
117. M. E. Grant Duff, Under Secretary of State, Indian Department.
118. Rev. John Barlow, F.R.S., late Secretary to the Royal Institution (deceased).
119. Divers, Dr. E., Lecturer on Forensic Medicine at Middlesex Hospital.
120. W. S. Squire, Ph.D., manufacturing chemist.
121. T. Malone, late Lecturer on Chemistry at the London Institution.
122. Dr. De Mussy, Physician to the Comte de Paris.
123. — Blanford, Geological Survey of India.
124. — Baker, analytical chemist, Sheffield.
125. Hakkin Effendi, }  
Hussein Effendi, } Turkish officers.  
Mohamed Effendi, }  
Barragan, }
127. Wall, Director of the Geological Survey of Trinidad.
128. W. H. Perkin, F.R.S., discoverer and manufacturer of the first aniline colour.
129. Frederick Drew, Superintendent of Geological Survey of Cashmere.
130. Ambrose Tween, of the geological survey of India.
131. — Gould, Superintendent of the Geological Survey of Tasmania.
132. S. Coomber, teacher of chemistry, Trade School, Bristol.
133. E. L. Barret, chemical manufacturer.
134. Wm. Kay, lecturer on chemistry at Stonyhurst College.
135. Richd. Thornton, mineralogist to Dr. Livingstone's African expedition (deceased).
136. E. Matthey, metallurgist, manufacturer of platinum.



137. Fr. B. Duppa, F.R.S., amateur chemist, author of numerous chemical researches.
138. Hy. Matthews, analytical chemist, London.
139. Wm. Weston, assistant chemist in the Portsmouth Dockyard.
140. Fr. Temple, chemical manufacturer.
141. Wm. Valentin, first chemical assistant in the Royal College of Chemistry.
142. Wm. M. Beaufort, lieutenant in the Indian army.
143. Ths. W. Danby, lecturer and examiner in chemistry at Downing College, Cambridge.
144. Gust. Schlieper, dyer and calico printer, Elberfeld.
145. — Austen, manager to Price's Candle Company.
146. Geo. Pilkington, glass manufacturer, St. Helens.
147. Montagu Gillott, steel pen manufacturer.
148. John Newlands, manager in sugar factory, London.
149. H. K. Bamber, analytical chemist, London.
150. Herbert McLeod, lecture demonstrator in the Royal College of Chemistry.
151. Alf. Gillet, steel pen manufacturer.
152. Wm. Merck, alkaloid manufacturer, Darmstadt.
153. Dr. Fillipuzzi, Professor of Chemistry in the University of Padua.
154. Major Ahmed Efendi, } Naval Cadets, sent by the
155. Ahmed Efendi, } Turkish Government.
156. Arif Efendi, }
157. Rt. Bruce Toote, of the geological survey of India.
158. Dr. Matthiesen, F.R.S., late Professor of Chemistry in St. Bartholomew's Hospital.
159. Le Neve Foster, D.Sc., mining engineer.
160. C. A. Barclay, brewer.
161. — Barclay, engineer.
162. Walter Child, late chemist to the Dowlais ironworks.
163. Wm. Hackney, assistant engineer to C. Siemens, F.R.S.
164. Hy. Barton, assayer, London.
165. John Davidson, teacher of chemistry in the Royal School of Naval Architecture.
166. Wm. Wyman, metallurgist, Chibi.
167. Mr. Tate, analytical chemist, Liverpool.
168. Wm. Topley, geological survey, England.
169. Lieut. Tulloch, civil service of India.
170. E. Bevan, } brewers.
171. Fr. Bevan, }
172. C. J. Mills, D.Sc., assistant examiner in the London university.
173. E. Thomas, chemical manufacturer.
174. A. Bevan, brewer.
175. — Longstaff, chemical manufacturer.
176. R. Wynne, mining engineer, Flintshire.
177. T. Levick, metallurgist in Australia.
178. T. Hughes, Indian survey.
179. E. J. Pearson, fireclay manufacturer.
180. Arthur Willis, chemist to Siemens' steelworks, Swansea.
181. E. Teschemacher, analytical chemist, City.
182. Dr. M. Simpson, F.R.S.
183. Dr. H. Goodrich, medical officer of health.
184. U. J. Kay Shuttleworth, M.P. for Hastings.
185. Thos. A. Dunnage, proprietor of lead works, Sheffield.
186. J. Allen, aniline colour manufacturer.
187. A. S. Herschel, Professor of Physics, Andersonian University, Glasgow.
188. R. P. Copeland, porcelain manufacturer.
189. F. H. Hobler, chemical assistant, Laboratory, Royal Arsenal, Woolwich.
190. Dr. Vollhard, Professor of Chemistry, Munich.
191. Dr. Martius, chemical manufacturer, Berlin; secretary to the Berlin Chemical Society.
192. Vernon Chater, paper manufacturer.
193. T. Tyrer, chemist to Chemical Works, Battersea.
194. Miles Smith, chemist to Messrs. Hopkin and Williams.
195. S. Temple, chemical manufacturer.
196. Arthur Vacher, analytical chemist.
197. Dr. Holzman, librarian to H.R.H. the Prince of Wales.
198. Dr. Graham, Physician, London.
199. H. W. Madeley, brewer, Messrs. Bass & Co.
200. Dr. E. Seward, Indian Civil Service.
201. E. B. Knobel, brewer in Bass's brewery.
202. Js. Clifton Ward, geological survey of Great Britain.
203. J. Carter Bell, analytical chemist, Manchester.
204. Wm. Chandler Roberts, chemist to the Royal Mint.
205. F. G. Finch, D. Sc. manager of ironworks, Blaenavon.
206. G. Schoeller, cotton dyer, Elberfeld.
207. Mons. Persoz, chemical manufacturer.
208. C. H. Dickens, Lt.-Col. Bengal Artillery.
209. J. T. Brown, assistant in Mr. Perkins' aniline works.
210. Charles P. Brown, Government Survey.
211. Henry G. Brown,
212. C. O. Sullivan, chemist in Burton brewery (Bass & Co.)
213. R. Googan, late chemist at Messrs. Hall's powder works.
214. Arthur Sopwith, mining engineer.
215. G. Hy. Benson, cotton spinner.
216. Werner H. H. Soames, soap boiler.
217. J. R. Doulton, pottery manufacturer.
218. Alex. Scott, sugar refiner, Greenock.
219. Charles Waterman, hop merchant.
220. Edwin Lapper, assistant to the Royal Veterinary College.
221. J. Graham Tatters, brewer, Messrs. Bass & Co.
222. Charles Duncan, dyer.
223. Wm. Thorp, principal assistant in the Rivers Commission Laboratory.
224. — Mallett, civil engineer, Bengal Service.
225. Lt. Louguinine, artillery officer, Russia.
226. Aug. Constable Maybury, D.Sc. London University.
227. James Price, varnish manufacturer.
228. Fr. Kuhlmann, junr., chemical manufacturer, Lille.
229. Dr. Leonidas Schuch, chemical manufacturer, Vienna.
230. James Craik, chemical assistant St. Thomas's Hospital.
231. Charles Piesse, chemical assistant St. Thomas's Hospital.
232. Wm. T. Rowden, science teacher.
233. Chs. Berrell, physician (deceased).
234. W. F. Richards, copper smelter, Swansea.
235. J. C. Brown, D.Sc. Lecturer on Chemistry, Liverpool.
236. Frank Rutley, Geological Survey.
237. Wm. Medland, wood-vinegar maker.
238. E. W. J. Jones, analytical chemist.
239. Alfred Murgatroyd, dyer and calico printer, Ridley print works.
240. Rt. E. Alison, assistant in the chemical laboratory, Woolwich Arsenal.
241. J. Liebig Muspratt, chemical manufacturer.
242. P. Holland, analytical chemist.
243. N. R. Griffiths, manager of ironworks.
244. S. Pontifex, chemist to sugar refinery, Demerara.
245. Js. Plimmer, manure manufacturer, London.
246. Captain Bolton, India Service.
247. Wm. G. Barnes, chemical manufacturer.
248. C. Berger, colour and starch manufacturer.
249. J. J. B. J. Grosjean, chemist to Mr. Lawes's chemical and manure works.
250. Fr. Rowney, colour manufacturer.
251. Wm. Hy. Deering, chemical assistant, Woolwich Arsenal.
252. E. Leigh Heseltine, quinine manufacturer.
253. Rt. Smith, steelmaker, Sheffield.
254. T. Hobday, brewer, Messrs. Alsopp & Co.
255. Edward Richards, manager of Barrow-in-Furness steelworks.
256. Geo. J. Snelus, chemist to Dowlais ironworks.
257. E. H. Davis, metallurgist.
258. Fr. Clowes, assistant in the Rivers Commission Laboratory.
259. Chs. O. Paget, civil engineer.
260. Wm. S. Greenfield, assistant to Wm. Siemens.
261. Captain Hozier, Horse Guards.
262. M. T. Salter, colour manufacturer.
263. David Watson, D.Sc., Teacher of Chemistry at Chester College.
264. A. Warner, metallurgist.
265. Jas. Day, assistant in Rivers Commission Laboratory.
266. Peter Cow, indiarubber manufacturer.
267. Hy. Armstrong, Ph.D., Professor of Chemistry in the London Institution.
268. Edwin Brown, brewer.
269. — Ferguson, brewer, Burton-on-Trent.
270. — Tomlinson, brewer, Messrs. Salt & Co.
271. — Goer, brewer, Messrs. Bass & Co.
272. Dr. Wichelhaus, Privat Docent, Berlin.
273. Ths. Ch. Cloud, metallurgist.
274. Th. Jones, science teacher.
275. Ed. Collens, manager of vinegar works.
276. T. A. Griffiths, Whitworth scholar.
277. Wm. Gomm Bell, metallurgist.
278. Wm. L. Pike, chemist to fire-clay works.
279. H. J. Brown, brewer to Messrs. Worthington & Co., Burton.
280. W. H. Thompson, chief assistant to the London gas referees.
281. H. H. Crucknell, physician.
282. E. C. Burr, chemical manufacturer, St. Francisco.
283. Irelan, junr., Do.
284. G. F. Edmonstone, barrister.
285. Herbert, I. Waterlow, stationer.
286. F. P. Blyth, cement manufacturer.
287. J. A. Hurst, chemical manufacturer.

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288. Raphael Meldola, chemical assistant to Dr. Stenhouse.
289. Alex. Pedler, chemical assistant in Mr. Perkin's colour works, and assistant examiner in chemistry to the Science and Art Department.
290. H. K. Hawkins, brewer, Burton-on-Trent.
291. — Wynne, assistant to Mr. Siemens, C.E.
292. H. B. Hederstedt, civil engineer.
293. T. H. Wilson, chemist to Muspratt's Alkali works.
294. M. F. Maury, mining engineer, Virginia.
295. G. Broome, professor of mineralogy, Toronto.
296. F. J. M. Page, chemical assistant in the Pathological Laboratory, St. Thomas' Hospital.
297. German Green, chemist in copper works, Newcastle.
298. Fr. Stocks, chemical assistant in Mr. Perkins' colour works.
299. J. Hunter Jones, civil engineer.
300. Kenneth Mackay, reporter to "The Times."
301. T. King, paper manufacturer.
302. — Nelson, gelatine manufacturer.
303. — Wollaston, Ordnance Survey.
304. — Peterson, the Mint, Calcutta.
305. A. Alcock, civil engineer.
306. J. D. Scott, sugar refiner, Greenock.
307. W. G. Whiffin, quinine manufacturer.
308. G. C. Chapman, metallurgist, Canada.
309. Wm. Stilwell, brewer.
310. Leonard Browne, science teacher.
311. Wm. Boden, brewer, Messrs. Bass & Co.
312. H. Daniel, brewer, Messrs. Salt & Co.
313. F. Fremlin, brewer, Messrs. Salt & Co.
314. Wm. Garnett, Whitworth scholar.
315. Alex. Bickerton, teacher of chemistry, Hartley Institution, Southampton.
316. T. W. Bayley, assayer, Royal Mint.
317. Edward Terry, mining engineer.
318. Js. Wm. Bell, jun., assistant in the laboratory of the R.C.C.
319. Ed. Midwinter, chemical assistant.
320. Js. Stoddard, chemist in Mr. Young's Paraffin Works.
321. R. Byramjee, M.D., Bombay Med. Service.
322. Gerald J. Hare, Indian Telegraph Service.
323. Chs. Bird, Do.
324. R. W. Butler, Do.
325. — Allen, Do.
326. W. Gordon MacGregor, Do.
327. — Pope, Do.
328. — Hullah, Do.
329. John Gavin, civil engineer.
330. Robt. Burnard, manure manufacturer, Plymouth.
331. Mr. Duffield, metallurgist.
332. Matthew Jackson, chemical manufacturer.
333. J. Clemes, manager of Silver Mining Company, Sierra Nevada.
334. Sidney K. Muspratt, chemical manufacturer.
335. Mr. Shadwell, barrister.
336. — Bell, brewer.
337. — Baylis, brewer.
338. Adrian Brown, chemical assistant St. Bartholomew's Hospital.
339. — Hetley, gas engineer.
340. J. T. Bowrey, Chemist to the Jamaica Government.
341. Ths. Charlesworth, dyer.
342. John Burke, Government Telegraph, India.
343. Wm. R. Toulmine, Do.
344. T. H. Lane, Do.
345. H. E. Thompson, Do.
346. Douglas Herman, chemist to plate glass works, St. Helen's.
347. A. C. Stewart, chemist to ironworks.
348. Chs. Williams, soap manufacturer.
349. Adam H. Blandy, civil engineer.
350. Walter Browne, Government Telegraph, India.
351. Wm. Soames, soap manufacturer.
352. E. Kinch, Chemical Assistant in the Royal Agricultural College, Cirencester.
353. Arthur S. Collins, manure manufacturer.
354. — Dillon, assayer, Royal Mint.
355. Tom H. Riches, Whitworth Scholar.
356. R. J. Friswell, chemist to pottery works.
357. — Hutchinson, wool dyer.
358. J. W. Bantock, chemist to White's gunpowder works.
359. John W. Hubbard, physician.
360. Lieut.-Col. Russell, Royal Engineers.
361. W. H. Greenwood, Whitworth Scholar.
362. M. H. Lackersteen, physician, Bengal Service.
363. F. R. Mallett, civil engineer, Indian Service.
364. Js. Parry, brewer.
365. — Barclay, manure manufacturer.
366. Geo. S. Packer, chemist to Cwm Avon iron and copper works.

These are students who have received their education

at the college of chemistry. In some cases the whole of their chemical training was not received there, but in most cases it was so. The Commission will see that many important positions in this country and our colonies are now held by men who have been trained in this college. I would point, in illustration of this, to the professors of chemistry in Nova Scotia University; in Queen's College, Galway; in the Royal College of Science, Dublin; in the University of Aberdeen; in the University of Cambridge; in King's College, London; in the University of Sydney; and in the Royal Agricultural College, Cirencester; and lastly to Mr. Abel, the talented director of the chemical establishment of the war department at Woolwich, who has been of very essential service to the department, in perfecting the manufacture of gun cotton, and in applying it with safety and certainty to warlike purposes. Mr. Abel's remarkable researches on gun cotton, published in the transactions of the Royal Society, have attracted the attention of all the Governments of Europe. Then again, you will find the names of almost every man who has been connected with the inventing and perfecting of aniline colours, the discovery of which has introduced a great and novel manufacture into this country. I have already mentioned the connection of Dr. Hofmann and Mr. Perkin with this discovery; but in the above list you will also find the names of Mr. Nicholson, one of the discoverers, and manufacturer, of magenta; and Mr. Medlock, also one of the discoverers of magenta; Messrs. Simpson and Maule, with whom Mr. Nicholson was associated in partnership, were also students in this college. There are also Mr. Field and Mr. Spiller, who are now carrying on the manufacture of aniline colours on a very large scale in London. There are many names also of gentlemen who have become managers of chemical and other manufactories in the country, and I direct your attention especially to this as showing that the original object for which the college was founded has been to a very great extent accomplished; to as great an extent as one could expect from the means at the disposal of the college, inasmuch as the number of students that can work at any one time is very limited. Not more than about 40 can be accommodated at once, and even that accommodation is very imperfect. I may say that the college is not capable of properly accommodating even 20 students.

5684. I think it appears that since the original foundation of the college over 1,000 students have passed through it; and in this list that you have prepared it appears that 366 of those who have studied there have more or less distinguished themselves, or at any rate are in such a position that their subsequent history can be traced, and that rather over one-third of those who have passed through the college may be considered as persons who have gained some distinction?—Yes; that is so. There are doubtless many others whose names might with propriety be added to the list, but whose destination we cannot ascertain, for no record of the destinations of students has been kept. I have compiled this table with the assistance of several of the older students of the college, who have kept an eye upon some of their former colleagues.

5685. Are the present students all of them, or if not all, what proportion of them, connected with the School of Mines?—I should say about one-third, or rather more than one-third of them. I presume your Grace means as associated students. They are of course all connected with the School of Mines, inasmuch as they make their entry at the School of Mines, but most of them enter as occasional students, and they attend the chemical course, and perhaps one or two other courses, but will not bind themselves down to attend the full course of study at the School of Mines.

5686. You do not receive any students, I presume, who are altogether unconnected with the School of Mines?—As the college is really a department of the School of Mines, and as a return has to be made to the Board of Trade, or to the Department of Science and Art, of every student who enters the school, I regard all of them as connected more or less with the School of Mines.



5687. Do some of them attend your laboratory only, who do not attend the lectures of any of the other professors of the School of Mines?—There are several who do so.

5688. Some arrangements have also been made, have there not, for providing lectures and laboratory instruction for science teachers?—Yes, for the past two years arrangements of that kind have been carried out. In the summer of 1869 a number of teachers came up to London for two or three weeks, and a small proportion of them worked in the laboratory of the College of Chemistry for a week, and attended lectures and demonstrations upon the teaching of chemistry, and various lectures upon other subjects given by my colleagues; and last year again this plan was considerably extended. About 120 teachers came up to town at the beginning of July, and heard six lectures on the teaching of inorganic and organic chemistry; they worked each of them for a week in the laboratory, being there instructed in the best methods of teaching practical chemistry or chemical manipulation. It was necessary to repeat this course three times in three successive weeks, because the laboratory could not contain more than about one-third of the number that came up—and this rendered the carrying on of the laboratory lectures, for three weeks instead of one, absolutely necessary.

5689. I think you have stated that you cannot admit above 40 at once?—40 is our regulation number, but we have had as many as 43 or 44 working; in such cases, however, several of them have been drafted into the private laboratory.

5690. (*Sir J. P. Kay-Shuttleworth.*) I understand there were six lectures given in the course of one week, and one week's laboratory instruction in a separate week?—One of the weeks of laboratory instruction coincided with the week in which the lectures were given; but there were three weeks of laboratory instruction. This course of which I am now speaking extended to the 21st of July 1870. There were six lectures given in one week, and a week of laboratory instruction given to each student; whereas, in the previous year, only one lecture was given, and all students who appeared there and were fit to take advantage of the instruction received one week's training in the laboratory. It was all done in one week in the summer of 1869. In connexion with the last teachers' class, I have some memoranda about the attainments of the teachers who came up. In the laboratory class I came into contact with each individual, because the instruction was given personally. Each man worked separately, and was guided by the teacher—myself or my chief assistant, Mr. Valentin—and therefore I had an opportunity of becoming acquainted with the mental capacity and attainments of those who came up. I find from my memoranda that 19 of the teachers possessed a good previous knowledge of practical chemistry, 22 a moderate knowledge, and 24 no knowledge whatever of this branch of the science. Of course I could not ascertain with sufficient clearness the condition of each individual, and the statement just given does not therefore cover the whole ground; but the great majority of the men who worked are included in it. It must be understood, however, that the term "good" as here used must be taken only in a restricted sense; in the higher sense it could be applied only to very few of the teachers. As regards progress in the class, 44 made good progress, and 18 moderate progress, whilst four made substantially no advance at all. The best science teachers in the country, however, having already an ample knowledge of the teaching of chemistry, did not come up on this occasion, and we must not take the above figures as showing with precision the general state of scientific education in the country. Nevertheless the better trained teachers are no doubt very rare exceptions. This spreading of the practical course over three weeks instead of one suggests the remark that the College of Chemistry is far too small, as I have already intimated, for the requirements even of the ordinary students. Several important branches of chemistry either cannot be taught at all, or can only be taught very imperfectly for want of more space.

For instance, the analysis of gases can be only very slightly taught practically. Spectrum analysis has to be ignored altogether, although it is one of the most important of the modern developments of chemistry, for there is absolutely no room where the instruments necessary for that purpose can be kept. Even inorganic quantitative analysis can be only imperfectly pursued, inasmuch as there is no separate room in which the necessary weighings of the substances can be made; they have to be made in the library, where the students who consult the books are constantly trampling about on the floor, thus preventing very accurate weighings from being performed. Then again the private laboratory, which in former years was devoted to research, has now to be devoted to the higher class of students in order to allow them an opportunity of pursuing their studies further; and this almost necessitates the giving up of original research in the College of Chemistry altogether, merely for want of space.

5691. Should you be able to take charge of a larger number of students if you had more space at your command?—Yes, certainly, with more assistants. I have at present in the laboratory two assistants, and I consider that in addition to the professor an assistant for every 20 students is the minimum that ought to be provided.

5692. Supposing the professor had an assistant for every 20 students, how many would he be able to take charge of?—With such help he might readily take charge of from 120 to 150, or perhaps even more, with good organisation.

5693. Have you any means of forming an opinion as to whether, supposing you had that amount of accommodation, students to anything like that extent would present themselves?—I have repeatedly had to refuse admission to students applying at the college; but I am not able to say to what extent the additional space would be filled, because the known incapacity of the college of chemistry to accommodate students who are pursuing the higher branches of chemistry precludes a number of men, who have previously received a part of their education there or elsewhere, from applying for places afterwards. They know that they would be put by the side of beginners, whose operations would probably spoil theirs, and it is consequently scarcely worth their while to come. There is in the College of Chemistry only one laboratory for students of all grades; the advanced and the beginners are all placed side by side. It is only of late years that I have given up my private laboratory of research to some half-dozen of the better students who are now permitted to work there.

5694. (*Professor Huxley.*) Do you happen to be aware that the Minister of Instruction in Wurtemberg has during a period of about the last three or four years pursued a plan similar to that which we have of late years been following, in having the teachers in elementary schools brought up and instructed in the method of teaching science?—I believe that that is the case.

5695. Have you seen the official documents referring to that?—No, I have not.

5696. (*Chairman.*) Are you able to give the Commission any information with respect to the period at which the lease of the present premises in Oxford Street will expire?—I understand from Captain Festing that the lease has still about 14 years to run.

5697. Is there space for any additions to the buildings in Oxford Street?—None whatever horizontally, there is vertically; it is not a very high building, it is only two stories above the basement at present.

5698. Is there an opportunity of making a more extensive laboratory on that site?—I think that it would be very undesirable. A building of that kind in a crowded thoroughfare, and especially with good houses at the back of it, such as those in Hanover Square, is undesirable. The neighbours sometimes complain of the nuisance from the gases we send up the chimney or which escape from the roof and windows.

5699. You would not think it desirable that any further outlay should be made on those premises?—I should not.

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5700. It would also be impossible, would it not, to provide buildings for the chemical department in Jermyn Street, at the School of Mines?—I think entirely so. I believe there is a possibility of purchasing an adjoining house there, but I do not think that that would furnish such accommodation as would be required for a really efficient laboratory for the instruction of science teachers; nor indeed for the instruction of ordinary students if the main building were kept to its present purpose.

5701. Are you acquainted with the plans of the buildings now in progress at South Kensington?—I am generally acquainted with them.

5702. Were you consulted in any respect with regard to the chemical laboratories?—My predecessor was consulted as to the drawing out of those plans, and subsequently after he had resigned the appointment I was requested to look over them, and I suggested one or two alterations, so far as alterations could then be made, in the way of subdividing one or two rooms; but there was nothing of importance altered.

5703. Have you considered that it was contemplated that the business of the College of Chemistry should be carried on at South Kensington?—I think it is very desirable that the chemical laboratory should be in a quieter and less crowded place than its present position, and that South Kensington would be a very convenient and desirable place in which to have such a laboratory, perhaps more desirable than convenient. Probably the students would prefer having a laboratory nearer to town than that, that is to say, nearer to the centre of London.

5704. Are the buildings at South Kensington, the laboratories especially, on a scale which would answer all the requirements which you consider necessary for a college of chemistry?—If entirely devoted to chemistry, they would form a laboratory which would be about equal to those that have been built at Bonn and Berlin recently by the Prussian Government, and at Leipzig, by the Saxon Government; and they would be a little superior, perhaps, to the chemical laboratory at Zurich, built by the Swiss Government.

5705. I believe that besides the lectures to the regular students, evening lectures are also given at the College of Chemistry?—There are, and indeed those lectures form to my mind an important part of the instruction given by the School of Mines. They are given at the School of Mines in Jermyn Street, and there are two distinct courses of lectures given, one to persons who cannot attend a course of lectures in the daytime. This usually consists of 10 lectures in each subject, and the courses to working men are courses of six lectures each; there are three or four I think usually of each of those courses given in the winter season, so that the evening class of students and the science teachers (for those lectures of which 10 are given in the course are intended for science teachers and those engaged in education) will hear 30 or 40 lectures in the winter, and the working men will hear 18 or 24.

5706. (*Dr. Sharpey.*) Are they 40 progressive lectures?—No, they are upon four different subjects.

5707. (*Chairman.*) The fee for attendance at those lectures is very small, I believe?—It is very small—for the working men it is 1*d.* a lecture, and for the others 5*s.* for the course.

5708. Do they pay their expenses by the fees?—Those in which the fee is 5*s.* do pay expenses, but those to the working men do not, and the professor has to defray them, as there is no allowance from the Government for the illustration of these lectures. In the case of the chemical lectures the cost of the illustration averages one guinea per lecture.

5709. Do they cover light and so on?—No, probably not light.

5710. (*Sir J. P. Kay-Shuttleworth.*) What is the number of teachers attending the evening lectures?—I have had no means of ascertaining what proportion of the 200 or 250 who attend are teachers, but I know that many teachers do attend those lectures.

5711. (*Chairman.*) They come in, do they not, as part of the public to those lectures?—They do.

5712. I think you said that you attribute great importance to those lectures?—Yes; I think, however, that the course is too short as given at present, but if those lectures were considerably expanded they would afford the means of scientific instruction to a large number of individuals who are precluded at present by their other occupations from pursuing those studies.

5713. Have you any means of ascertaining what results are derived from those lectures; whether those who attend them acquire much information?—I can only judge of that by the attention they pay to them, and the copious notes which many of them are seen to take; but there are no examinations connected with them directly. Many of those, I have no doubt, who come to the evening lectures go in to the May examinations of the Science and Art Department, but I have no means of identifying them as persons who attended those lectures.

5714. (*Professor Smith.*) Have you considered what would be likely to be the effect of a great extension given to the Royal College of Chemistry upon those voluntary and purely self-supporting institutions which at present teach chemistry?—I do not presume that it would exercise much more effect upon them than it does at the present time. Of course it absorbs a certain number of those who intend to devote themselves to the study of chemistry, but inasmuch as the College of Chemistry offers far less pecuniary advantages to them than the private institutions, I should not anticipate that it would absorb a larger proportion than it does now. A certain number of students who look to taking prizes and scholarships would rather go elsewhere than to us, for our prizes are very meagre compared with those offered by University College, or by Owen's College at Manchester.

5715. Is there any other respect besides scholarships and prizes in which you think institutions not connected with the Government, offer any pecuniary advantages to their students; are their fees lower?—All their fees are invariably lower than ours. Our fees are very much in excess of those of the other schools.

5716. (*Dr. Sharpey.*) What is the fee at the College of Chemistry for the laboratory?—The fee is 36*l.* for the session of nine months; and more, unless a term equal to three months is taken at once. It may be divided into three portions of 12*l.* each, but if the two months be taken, the fee for the two months is 9*l.* instead of 8*l.*, and the fee for one month is 5*l.*

5717. Does that include the expense of materials?—Of the ordinary reagents, but not of the apparatus.

5718. Such materials as sodium and potassium the pupils would have to pay for?—Yes, and the pupils would have to pay for silver, gold, and platinum, and they have to find their own apparatus, the first cost of which is about 3*l.*

5719. (*Professor Smith.*) As a matter of principle, do you think it desirable that the scale of fees should be distinctly higher in a Government institution than in private institutions?—On the contrary, I should rather say it ought to be lower,—at all events, not higher; but there is not much incentive to the lowering of the fees, if more students apply than you can accommodate. I think, however, that the fees are too high; they are very much higher than on the Continent.

5720. Then you would not see any objection to running the risk of seriously injuring those institutions which are entirely self-supporting, or less supported by external assistance, by lowering your fees?—I do not think that they would be injured; I believe that any impulse that was given to the study of chemistry by our institution in that way would affect the others, and in all probability increase the number of students attending them. It must be understood, however, that the assistance given by the State to the College of Chemistry is of a very partial character. The expenses of the laboratory have to be entirely defrayed by myself. All I get from the Government consists of,



first, the building and fittings; secondly, fuel; and thirdly, gas. Everthing else I pay for; all the assistants connected with the laboratory are paid by me. I have one assistant for the lectures who is paid by the Government, and the Government allow 60*l.* per annum towards the expenses of the lecture illustrations, but they allow nothing towards the expenses of the laboratory in any way. On the other hand they take no portion of the fees of the laboratory students, but they claim and exercise the right of sending their exhibitioners and scholars at reduced fees.

5721. (*Mr. Samuelson.*) You stated, I think, that there still is some considerable term of the lease of the buildings in Oxford Street to run?—I have had that verbally from Captain Festing. So far as my memory serves me, there is something like 14 years to run.

5722. There is at all events a considerable term to run?—I believe so.

5723. And the rent is 130*l.* per annum I believe?—Yes.

5724. Would you consider the value of those buildings to be such that they could be readily let for the remainder of the term at that rent?—One portion of the buildings has been so let for many years past. The house in Hanover Square, which was the residence of the professor at the commencement of the college, has been so let I should think for 16 years or more, but the college itself and the lecture theatre would not be likely to be let in their present condition. I am informed, however, that the Government could very readily make use of those buildings. It was contemplated at one time to make them into a post office. That, however, has gone by now since the establishment of the west central post office near to it, but there is a department of the Geological Museum in Jernyn Street, namely, the Mining Record office, which is very much cramped for room, and that could be transferred with advantage to the buildings of the College of Chemistry.

5725. So that we should still get the same value for the 130*l.* per annum?—Yes.

5726. At the time when the College of Chemistry was established there were classes of chemistry at King's College and University College, were there not?—There were, and also at the Museum of Practical Geology.

5727. And notwithstanding that the want of such an establishment as the College of Chemistry was strongly felt?—It was very much so; and the appeal to the country generally for subscriptions was very handsomely met in the first instance. A large number of subscriptions flowed in, but as is generally the case in such operations, the subscribers gradually fell off, and no fixed and trustworthy income could be kept up for the College, so that if it had not been transferred to the Government, I believe it must have been closed for want of funds, as such institutions cannot be self-supporting.

5728. Would you say that at the present time this College answers a specific purpose which is not fulfilled in an equal degree by any other institution in London?—In my opinion it does, inasmuch as it pays more specific attention to the applications of chemistry to manufactures than is the case in any other institution. In other institutions the course of instruction has to be guided with reference to several classes of students. You generally have medical students and art students attending them, and finally students of the class attending the school of mines, and the course of instruction has to be shaped, as far as possible, to suit all those three classes of students. We are not under this restriction with regard to the direction of the instruction.

5729. And that freedom induces you to develop your teaching in what way?—On the practical or technical side. We also endeavour, although this is not peculiar to the College of Chemistry, to induce every student to study his science experimentally, and by bringing himself personally into contact with the phenomena, so that he may afterwards become himself a worker in the science, and perhaps an investigator.

5730. Perhaps you would say that in the other institutions chemistry is rather one branch of a general education, whereas, with you, you afford a special training for men who intend to devote themselves to the profession of chemistry?—That is exactly so. Our students devote themselves almost exclusively to chemistry; even the regular students of the School of Mines attend in their first year, besides chemistry, only 40 lectures on physics, and a few lessons in mechanical drawing. Their attention is therefore concentrated upon chemistry as a speciality. Again, the instruction in the lecture class is on the one side more profoundly theoretical, and on the other much more technical than would be suitable for a mixed class. A considerable proportion of my lectures would, for instance, be quite unsuitable for medical students. An inspection of the syllabus of the chemical lectures, at pages 14 to 18, will show what a large amount of attention is paid to technical matters. When I left St. Bartholomew's Hospital, and went to the College of Chemistry, I made a profound change in the character of my course of chemical lectures.

5731. And for that species of instruction you say that there is a demand which you are at present unable to comply with?—There is.

5732. You have spoken of the deficiencies of your laboratory, and you have also adverted to the new laboratory now about to be completed at South Kensington; is there not a very great step from the accommodation which you now have to that which will be provided there?—Undoubtedly, we have perhaps not one-tenth of the space that is provided there.

5733. Do you consider it essential, in the present state of the demand for scientific instruction in this country, that the accommodation should be at once multiplied by ten?—I do not think that the new building will be at all too large for London alone, with its 3,000,000 of inhabitants; as Switzerland, with 2,500,000, does not find a superabundance of room in the chemical laboratory of Zurich, which is of about the same size. It is quite necessary to provide for three classes of students in such an institution. You ought to have almost a separate establishment for each of those three classes. First, the laboratory for beginners, and connected with that laboratory you would require all the offices that we have at present at the College of Chemistry, and even more, for we should be even short of room for that purpose. Then there ought to be a laboratory for advanced students who are engaged in quantitative analysis, and we want, in fact, at least four special rooms for their various operations, so that one set of operations shall not interfere with the others. It is quite essential that those students should be separated from the beginners, whose manipulations very frequently spoil the results of the quantitative students, which have been obtained by days or even weeks of labour, and which may be spoilt in a moment by sulphuretted hydrogen or other gas evolved by a beginner on a neighbouring bench. And thirdly, you ought to have a laboratory for original research. So that you want three sets of rooms, as it were, in a laboratory which is at all to come up to the requirements of the study of chemistry at the present day; one for beginners, one for advanced students, and one for original research.

5734. You are probably aware that some of the professors, indeed, I may say, all the professors of the School of Mines are more or less complaining of want of space?—Yes; that is so.

5735. If some of them were to put in a claim for accommodation in the new building at South Kensington, do you think that a compromise could possibly be effected by which you might cede a portion of the space to them?—Yes; I think so. It is not at present contemplated to devote the whole of that building to chemical purposes; it has never been contemplated to do that. A portion of it is intended for the Royal School of Naval Architecture. If the Royal School of Naval Architecture could be accommodated out of that building, I think that two departments at least, if not

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three, could possibly co-exist side by side in that building.

5736. Then in speaking of the space being occupied too greatly, you refer to that portion only which is intended to be devoted to chemistry?—Quite so. The whole of the ground floor is devoted to the School of Naval Architecture, and that is a very important part of the building.

5737. Can you tell the Commission what is contemplated with regard to the instruction of teachers this year, 1871?—A circular has been addressed to science schools, proposing a term of six weeks' instruction, instead of lectures lasting only for a week or fortnight. It is under consideration to have some few regular courses of instruction, including laboratory practice and practical manipulation in different branches of science, extending over about six weeks during the months of June and July, when the Royal School of Mines, the Royal College of Chemistry, and the Royal School of Naval Architecture are not in session. There is, however, some misapprehension here. The School of Mines, and the Royal College of Chemistry, are both in session in June, and consequently the programme announced in this circular cannot be completely carried out.

5738. Have you heard at all what is the number of teachers expected to come up for instruction in your department this session?—I have not.

5739. You say that you were brought into contact with some 60 or 70 of the provincial teachers last year, and you stated to the Commission the degree of knowledge of practical chemistry which they possessed; had you any means of judging of the degree of proficiency in theoretical chemistry possessed by those, say, 24 for instance, who had no knowledge of practical chemistry?—Yes; those who had a fair knowledge of practical chemistry possessed generally a pretty good knowledge of theoretical chemistry, whilst some of the others who were very much behindhand in practical chemistry, nevertheless manifested considerable knowledge in theoretical, that is, in subjects that could be learned from books, as distinguished from those which could be acquired only by actual work in a laboratory. Most of those men had obviously never manipulated before in a laboratory, and had no notion of teaching chemical manipulation to their pupils.

5740. From the fact of their having taken the pains to come up to be taught you would attribute to them some amount of zeal in the pursuit of science under difficulties?—Yes, undoubtedly. Almost to a man they expressed themselves to be very anxious to avail themselves of such opportunities in future, and they wished that the time of instruction could be extended. They felt, as indeed I did, that a week was quite inadequate to give them anything like the information they ought to possess, before they themselves began to teach. Some of them were also anxious to come up at a different time of the year. They said that July was a very inconvenient time of the year for them to come. The notion of the majority of them, as I gathered, was this, that they would wish to be allowed to come for a definite period, whatever it might be, at any time of the year that would suit them. That obviously could not be done with the present limited space at the College of Chemistry, whilst in several other departments of experimental science there is at present no provision whatever for practical instruction in the Government institutions.

5741. If you excepted the few men of whom you spoke as being thorough practical chemists, you might, I presume, look upon those as above the average of the chemical teachers in connection with the Science and Art Department?—They were specially selected as teachers who had some knowledge of chemistry, and were therefore likely to gain the most advantage from the course.

5742. And yet you found them very deficient in preparing or the office of teacher?—Yes, very.

5743. I need scarcely ask you what conclusion you would draw from that as to the capacity of the teachers generally?—I think it would be unfair to draw the conclusion that the teachers universally were

so deficient as most of those men who came up, because, as I said before, the probability is that the best teachers would not come. I had only two or three instances in the entire number of really first-rate teachers,—gentlemen that I was rather surprised to find coming up to this class. The teacher of chemistry in the Midland Institute—Mr. Woodward, and Mr. Jarman of Huddersfield, I may mention as two instances of gentlemen who are thoroughly competent to teach, and who came, I believe, from a desire to see the methods adopted at the College of Chemistry.

5744. I think you stated that you considered those superior men to be very rare?—Yes; very rare. I think we should not find many of them in the country.

5745. And moreover, those who did come up were selected, were they not, from the teachers at large?—Yes; from the great mass of science teachers.

5746. And the account you have given of their proficiency is that, upon the whole, it was not great?—Certainly.

5747. Do you know how the selection was made?—I do not; it was made, I believe, by Captain Donnelly, but I do not know upon what principle it proceeded.

5748. But the intention was, I presume, that the men most likely to profit by such instruction should come up?—Yes. Captain Donnelly told me that he should confine the invitation, as far as possible, to those who were known to have some knowledge of chemistry, and who were likely therefore to benefit by such instruction.

5749. You said that with additional assistants it would be possible for the professor to undertake the instruction of from 120 to 150 students. I suppose that amongst those students you would expect to find some of considerably higher professional attainments than the others?—Yes, certainly; and with regard to the assistants, I am of opinion that the higher class of assistants ought, in addition to affording help in the laboratory, to give courses of lectures. I find every where in the German Universities that this is the case—the higher assistants give subsidiary courses of lectures, which are of great service to the junior students. Those courses could scarcely be given by the professor himself, who has a general and higher course to give, without unduly taxing him; but they are very well given by the assistants, upon such subjects as analytical chemistry, special applications of chemistry to technical purposes, and special lectures upon spectrum analysis, and particular portions of chemistry. Such subsidiary courses of lectures are highly appreciated in the laboratories in Germany, as I know from experience.

5750. Then the status of some of those gentlemen would be rather that of assistant professors than of mere laboratory assistants?—It would.

5751. And of course their remuneration would have to be upon a corresponding scale?—Yes, you could not expect to retain the services of a really good man unless you gave him a fair salary. At the same time a portion of his remuneration might be derived from fees.

5752. You said that some of the students might not consider South Kensington to be quite so accessible as Oxford Street, but is it not the case that the Metropolitan railway affords great facility of access now to South Kensington?—Yes it does, and that certainly takes away much of the force of my objection. This is an objection that I had heard urged by the students before that railway was opened, when it was contemplated some years ago that the laboratory should be removed to South Kensington; some of them objected upon that ground, but I think that their objections would probably not now be made.

5753. In fact, South Kensington is much nearer to a Metropolitan station than the college in Oxford Street?—It is much nearer; it is within two minutes' walk of the South Kensington station.

5754. You think, do you not, that the classes for teachers, and the laboratory instruction given to teachers, have been useful?—Yes, certainly. So far as it went it was of great assistance. Many of the teachers



expressed themselves much gratified by it, and wished that they might have an opportunity of continuing it upon subsequent occasions. In proof of this I may cite the following extract from a letter just received from one of them:—"I am very pleased to hear that a training college for science teachers is to be opened so soon. It is indeed capital news. I am sorry that there seems to be no regulation for teachers to come to London for instruction in chemistry this year. I learnt more practical knowledge in the one week I was there than I should have done by plodding on for a whole year by myself with the little time I have at my disposal for this subject. One result is, that I have been able to fit up a decent laboratory for 10 students." The course was too short, extending only over a week.

5755. But the amount of instruction given must necessarily have been limited?—Yes, certainly. When I tell you that our regular course of elementary instruction in chemistry extends over nine months, and that the students work every day from 10 or 11 until 5, except on Saturdays when they leave off at 2, you will understand that a week is a very small fraction of the time necessary to be devoted to this subject.

5756. When the new laboratories at South Kensington were first projected and sanctioned, do you know for what purposes it was intended to apply them?—I do not. I may say that I have never had full information of the details of the intentions of those who contrived them.

5757. But do you contemplate their application as a school for training science teachers to be a desirable one?—I have myself recommended that they should be devoted principally to that purpose.

5758. Do you think that it would be possible to form science teachers having a satisfactory knowledge of their science without some institution of the kind?—I do not, at least it would be a very slow process. If we are to make good the ground lost by years of inaction, some such energetic step must be taken, otherwise the growth of a sufficient number of science teachers in this country will be a process so slow that we shall be left, for a long time to come, in a very bad condition as regards education in experimental science.

5758a. And from what you know of other physical sciences generally, would you say that the same urgency exists in respect to them?—I think even more so than in the case of chemistry, for chemistry is a science which has been cultivated in this country more than any other experimental science.

5759. Then you would look upon the establishment of a training college for science teachers of different departments of science as probably the most desirable purpose to which that building could be devoted?—I should certainly.

5760. Have you seen a scheme prepared by Captain Donnelly the official inspector and laid before this Commission with reference to a training college for science teachers?—I have.

5761. Have you given it any consideration?—I gave the chemical portion of it my close consideration, and I think I made one or two alterations in the original scheme as it came to me. I see that two demonstrators are put down in that scheme at 600*l.*, but it does not quite appear that there are to be other assistants besides those, probably however the item "laboratory including the staff," includes the assistants of a lower grade; but I think that a sufficient amount has scarcely been scheduled for that purpose.

5762. Do you think that so far as chemistry is concerned it is estimated rather within than beyond the mark?—Yes; as regards the current expenses of the laboratory. The item "laboratory, including the staff, &c.," I think is underrated, because the present cost of the College of Chemistry (which only provides for 40 students), independently of the building, taxes, and fuel is something like 700*l.* a year, whereas the figure here is 650*l.* You certainly would require for an institution such as is contemplated at South Kensington in addition to the two demonstrators, three or

four assistants, if you are to have 120 or 150 students there.

5763. (*Dr. Sharpey.*) Is that sum put down for the special expenses of the instruction that would be required for the science teachers; or is it a part of the general expense of the College of Chemistry?—That is the expense of the chemicals that are used by the students. It includes also the wages of the men who are employed to clean up the place, and keep it in order, and the salaries of one senior and one junior assistant.

5764. Would not that be extra upon the ordinary expense of the College of Chemistry as it exists now; is it not intended specially as an expense to meet the case of the science teachers?—If that be the case, of course the conditions I was contemplating would not obtain; but to give an estimate of that kind it is necessary that the number of teachers should be taken into consideration. If you were to estimate for 120 teachers, I should say that the cost of training 120 teachers in this laboratory, independently of all salaries, would be from 900*l.* to 1,000*l.* a year.

5765. But each of those 120 would not remain, of course, the whole time, but merely for a limited time?—No, but I am contemplating the place being always filled by 120 teachers, though not necessarily the same individuals, and for that number I think that less than from 900*l.* to 1,000*l.* would not be sufficient.

5766. (*Mr. Samuelson.*) Would you contemplate receiving into this training college ordinary students, such as you now receive in Oxford Street?—It would be desirable to have a small class, at all events, of such students, for the teachers to work with. I think that the training of those pupils in the same building would be an advantage to the teachers themselves, because the more advanced teachers would be set to train the beginners, under supervision.

5767. Then the combination of those two objects would not be a hindrance to either, but rather a benefit to both?—It would be a benefit to both, and if there were room I should admit both, but if not, then I would exclude the ordinary students, and take in the teachers only.

5768. Credit is taken for saving in the existing institutions, and I think it is also mentioned in the explanation accompanying the Minute that a large amount is now paid by the Government for chemical investigations, which might be carried on in the proposed training college; can you speak to that?—I may give you as an instance a quantity of work which is being performed now for the Royal Commission on the pollution of rivers and for the local government department, and which might be very well carried on in this institution. The cost of that laboratory in Victoria Street will be found in the estimates to be 900*l.* a year.

5769. And something of that kind is always going on, is there not?—Yes; that is one of many doors to expense of that kind which would be to a great extent closed.

5770. Is it the case that the Commissioners of Inland Revenue have a laboratory of their own?—They have.

5771. Would it be possible, in your opinion, to carry on the operations of that laboratory at an institution of this kind?—Yes, it would; but then we should have to enlarge our building. Their operations are also of a very special character, and I think that it would be preferable that they should be carried on in a separate building, because they are essentially of a secret nature, and it would not be desirable that the people engaged in those operations should be liable to be overlooked by the other students.

5772. Can you put on record any other investigations which have now to be paid for separately, which payment would be saved, besides that of the Rivers Pollution Commissioners?—There are numerous chemical analyses of water and other liquids made for the Privy Council Office, the expense of which would, to a great extent, be saved, and analyses that are frequently required for various Royal Commissions,

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I mean temporary Commissions, and which are paid for,—such, for instance, as the extensive series of analyses of the waters recently made for the Royal Commission on water supply, which cost between 500*l.* and 600*l.* Such an item as that would be saved to a great extent. You would require an additional assistant or so for the execution of such analyses. Other matters of a similar kind are constantly occurring in various departments of the Government, and I think a good many of those could be executed in an institution of this kind, if sufficient space were provided, with comparatively little expense to the Government.

5773. (*Sir J. P. Kay-Shuttleworth.*) Is there anything done for the police with respect to the adulteration of food?—No; but that ought to be made a separate department, as is the case in the Zurich laboratory, where there is a special toxicological department, which has a separate part of the building to itself.

5774. You would not think it wise to put into a department paid by the Government toxicological inquiries which had any relation to judicial decisions?—I think not; besides, if you make the professor responsible for all those things, you would put too much upon his shoulders.

5775. (*Mr. Samuelson.*) It would be rather with regard to general than to special inquiries?—Yes.

5776. How is the chemical instruction now given in the School of Naval Architecture?—It is given partly by lectures and partly by laboratory practice. The lectures are now being given by my principal lecture assistant, Mr. McLeod, one of the demonstrators of the College of Chemistry. And the students of the Royal School of Naval Architecture have also instruction in the small laboratory at South Kensington, where, however, the arrangements are very imperfect, and some classes of operations cannot be performed at all. I have some difficulty in examining those students practically, because they are not allowed to use sulphuretted hydrogen, which is an essential thing for conducting most practical experiments.

5777. Would it be possible to give chemical instruction to any of the other Government departments, for instance, to the military colleges in or near the metropolis, in this laboratory?—There would be every facility for it. I may mention that the Inland Revenue laboratory frequently sends its students to the College of Chemistry to be instructed. I have generally from four to eight of those students attending the lectures. They receive only lecture instruction at the College of Chemistry, their laboratory instruction being most efficiently given in the Inland Revenue laboratory at Somerset House.

5778. And in this way do you think it would be possible to abolish any of the existing charges which are incurred for chemical instruction?—I think so. There would be a difficulty about carrying it out in every case, I am afraid. You must have a military school, of course, in Woolwich and other schools of a similar kind, and if the students came to South Kensington for their lectures, there would be a good deal of time wasted, so that such a centralization of chemical instruction could only be partially carried out with advantage.

5779. It might be useful, perhaps, for the higher pupils?—It might; and a training in the laboratory at South Kensington might be available in the case of those schools.

5780. So that the instruction at the school might be of a more elementary kind, and the higher instruction might be given in an institution like that which is contemplated?—Quite so.

5781. (*Sir J. P. Kay-Shuttleworth.*) Staff officers of engineers desirous of pursuing their studies in chemistry, and of attending upon other courses of investigation, might be working at that institution?—Yes, certainly. We have had a few instances of that kind. Colonel Reynolds and Captain Hozier, for instance, worked with us at the College of Chemistry.

5782. (*Professor Huxley.*) I suppose I may assume that you have taken an interest in chemistry as student, investigator, or professor, now for about 25 years?—Yes.

5783. There has been a very vast growth in the development of chemical study within that time in this country, has there not?—Yes, very great indeed.

5784. Could you give even the roughest sort of general estimate of the number of people who are practically studying chemistry now as compared with the number who were studying when you began your work 25 years ago?—I must confine my estimate to England. I know nothing with regard to the state of things in Scotland at that time; but referring merely to England, I should think that at that time there were not 20 students getting instruction in practical chemistry in the whole country of England. That was just before the opening of the College of Chemistry.

5785. (*Sir J. P. Kay-Shuttleworth.*) Excepting for the medical profession?—Precisely so. There was a kind of practical instruction given to medical students, but it could scarcely be called efficient practical instruction. It generally consisted in a teacher demonstrating before a class for about an hour on certain days for three months.

5786. (*Professor Huxley.*) With reference to that point, as a matter of fact it was a rare thing, was it not, for the students of chemical classes in the medical schools to be put through practical instruction in anything like what we understand as practical instruction now?—Yes, certainly; and in fact it is so even at the present time.

5787. Have you taught in a medical school yourself?—I taught in St. Bartholomew's hospital for upwards of six years, and the practical instruction there I know at the time was carried rather further than in any other medical school in London, and that consisted of 2½ hours' work twice a week for three months.

5788. I presume I should be safe in assuming that there are ten times as many people engaged in the practical study of chemistry now than there were when you commenced your studies?—I should think that would be considerably within the mark.

5789. From what you see of the course of affairs in this country and elsewhere, is it your opinion that the practical study of chemistry is likely to increase at an equally rapid rate in the next 25 years?—I should anticipate that the increase would be in a still more rapid ratio.

5790. Under those circumstances, considering that there are 3,000,000 of people in London, or thereabouts, is it not probable that in the course of the next 20 years there will be occupation, not only for as large a laboratory as that which is now building at South Kensington, but for three or four more laboratories within the area covered by London?—I should certainly anticipate that that would be the case.

5791. So that any competition into which the State Laboratory may enter with others, will be practically limited by its dimensions, and can have no practical effect?—That is my opinion.

5792. (*Sir J. P. Kay-Shuttleworth.*) You referred in the earlier part of your evidence to the examination into the power of research which occurs in Germany; could you describe to us what that examination is?—In the Prussian Universities, and in several of the German Universities, the practice in granting degrees in science or in philosophy, as they call it, is not to admit the student to examination at all until he has sent in a memoir upon an original research executed by himself in the laboratory of some professor of the University, or of some other known person who can authenticate this memoir; and he is also not admitted to examination until this memoir has been circulated amongst the members of the faculty, and has been pronounced to be sufficient evidence of his power to carry on research.

5793. We have before us a table sent in from the Department of South Kensington, showing to us that the science teachers in Great Britain and Ireland number



about 566 teachers of elementary day schools, and 311 who are not teachers of elementary day schools many of whom have other occupations than teaching. I think it desirable to distinguish, in the question which I am about to put to you, between the teachers of elementary day schools and those who are not teachers of elementary day schools; have you formed for yourself any distinct conception of the course of study which you would devise for the improvement of the power of a teacher of an elementary day school in a science class in the country?—Yes; I think I could prescribe a definite course of training which would be suitable to a teacher of that kind.

5794. And in order to give him a power of manipulation sufficient for demonstrations in a class, and a sufficient power of theoretical teaching, over what period do you think it would be indispensable that his instruction should extend at such a central school as has formed a considerable portion of the subject of the examination to-day?—It ought to extend over nine months, six months would be the shortest period, but it would then probably be rather imperfectly done. Nine months would be the normal time in which he would gain that amount of information and manipulating power which would enable him to teach well afterwards.

5795. You are aware that the ordinary course of education for an elementary day school teacher is, first, five years' apprenticeship as a pupil teacher in a day school; then two years' training in a training college; and then after that he, commonly having no resources with which to support himself, takes charge of a day school; at what period of his career would you think it reasonable to interpolate the nine months of scientific instruction, putting aside the question of resources?—I should be inclined to put it at the end of the five years' apprenticeship, that is to say, to take the nine months after the last year of the apprenticeship.

5796. His apprenticeship ordinarily terminates at 18 years of age; he then spends two years in a training college; at the end of that time he ordinarily is 20 or 21, and the apprenticeship leads up to the instruction which he obtains in the training college. Would you think it more convenient to place that period of instruction between the apprenticeship and the training college, or after the instruction in the training college, seeing that his general powers of working or reading would be greatly increased in the training college?—On the understanding that he passes through the two years in the training college subsequently to his apprenticeship, I think, if on other grounds it would be equally convenient, it would be more desirable that he should take his science training at the end of that time.

5797. On the other hand, you think that the master of an elementary school, receiving nine months' instruction, would be a person fitted to take charge of scientific classes, and give instruction in chemistry in a most effectual manner?—Yes; he would be a much better teacher I should say than nine-tenths of the people who are now giving instruction in experimental science.

5798. He might be competent, for example, to be an organising master of district evening schools?—Yes; if he were an intelligent man he might even aspire to that position after nine months' training.

5799. He might give evening instruction in some of a group of mechanics' institutions, and he might give day instruction to teachers in the district in which that group existed, so as to be himself a source of powerful impulse to scientific instruction in that district?—Undoubtedly.

5800. You would scarcely contemplate, I presume, that a master having had that nine months' instruction, after seven years' previous instruction, would be content to be simply a master of an elementary school, in which the minimum of science would be introduced?—Something would depend, of course, upon the rate of remuneration that he obtained there. I believe that the masters in some of those schools are very fairly paid. I know one instance of a man of this kind who

gave instruction in an elementary school, and who, not by nine months' of special training, but by an equal amount of hard work upon his own part, made himself a thoroughly good teacher in physics, and partly also in chemistry, and who still holds that position.

5801. How much is his remuneration?—I believe about 300*l.* a year.

5802. But you are aware that the average remuneration of an elementary schoolmaster is not above 90*l.* a year?—I am not very well acquainted with that.

5803. My question related to the average level of elementary schoolmasters, and it was intended to ascertain from you whether you considered that a man trained by the seven years which I have described, and by the nine months of scientific instruction, would be content with the possession of a house and 90*l.* a year, which is the average rate of remuneration; or whether he would not be better fitted to be the organising master of a district in which, with the aid at present given by Government, he might frequently get 250*l.* or 300*l.* a year?—I think there can be no doubt that, with the discontent which generally prevails amongst people with regard to their position, he would try to do something of the kind, and would endeavour to improve his position as rapidly as possible; but I am far from considering that, in so doing, it would be desirable he should discontinue his functions as an elementary schoolmaster.

5804. If for example an elementary schoolmaster, had to teach five hours at school in the day, and had besides that an hour and a half of instruction which it was necessary for him to give to his pupil-teachers, making six and a half hours, of positive hard work in the day, would you expect that such a man having likewise if he conducted his school efficiently, to spend one or two hours in study every night, would have the energy either of mind or of body to bestow upon anything but the instruction of an elementary school in his own village?—For his own good it is perhaps not desirable that he should do so, but I believe there are many men who do devote their evenings to other kinds of instruction after spending the day in the manner which you describe.

5805. Do you not see that in the pursuit of emolument he might be led, however high his principle was, through sheer exhaustion of mind and body, to neglect the elementary school or to become a less efficient teacher than he would otherwise be in a science school?—I think that is very likely.

5806. So that in fact the chief hope of the use of those instruments for instruction in the country might be clearly seen to be this, that there should be a sufficient group of schools and a master who could be highly remunerated as an organising master, and who should have under him the accessory aid of elementary teachers or others who should give such an amount of attention to the instruction of evening classes as would not exhaust them in mind and body?—Yes, that would be desirable, but still I do not see the possibility of giving efficient scientific instruction, especially of a practical character nor even indeed of a theoretical character, unless the teacher who actually gives it, not some one who is above him, but the one who actually gives it, is thoroughly acquainted with the subject.

5807. When I spoke of the man who is above him I intended that that man should himself conduct, not merely the theoretic instruction, but likewise the practical instruction of the class, at least one or two evenings a week, whilst he was aided by the elementary master at other periods?—Probably after the lapse of some time the elementary master would gain sufficient acquaintance with the science that he was teaching to become to some extent efficient, but I am afraid that at first that plan would not work well.

5808. I am supposing that the elementary master should himself have had a scientific training in a training college subsidiary to his other studies, so as to make him competent to be a fairly efficient teacher with the aid of the organising master, whose higher qualifications you have yourself defined?—If he possessed sufficient elementary knowledge of an accurate kind

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14 Feb. 1871.



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of the science which he taught, he would no doubt be a good deal aided in teaching by the organising master being over him.

5809. That which I have been desirous to bring before your attention has been this, the practical necessities which environ an elementary schoolmaster, both during his training and after his training, when he is in charge of an elementary school; and that those practical necessities indispensable render a higher class of teachers in the country than the elementary schoolmasters with some scientific training, that is to say, men specially prepared by the nine months' training which you have described. Turning to the other class of science teachers, who are not day schoolmasters, you are aware, are you not, that the majority of those have not had the training that I have described, either as apprentices or the two years in a training college?—I presume that a considerable majority have not had that training.

5810. In fact they have had but an imperfect education, the greater part of them have been either self-educated or educated with the aid of that imperfect instruction which is commonly given in the inferior mechanics' institutions?—Yes.

5811. Then they have superadded to this, mainly by their own efforts, or by the aid of science teachers, some instruction in the barest elements of science, chemistry being now the question before us. You could not of course consider that class of teachers as instruments from whose labours you could expect any very considerable result?—No, so long as they remain in that embryonic condition I think they are scarcely worth calling teachers.

5812. I presume that the use of such teachers is rather to be regarded as an expedient in the absence of better teachers?—Certainly, merely in the absence of better, they are better than none at all, probably. They at all events keep up some interest in the subject.

5813. To create a feeble and transient interest in the subject?—Yes.

5814. (*Marquis of Lansdowne.*) You were asked with regard to the possible competition of the College of Chemistry with other institutions. Will you state what institutions you spoke of when you said that you did not apprehend much danger on that score?—I meant the other chemical laboratories of instruction in London; for instance, the University College Laboratory, the King's College Laboratory, and the laboratories of some of the medical schools, which are open to special students of chemistry, independently of the medical students. Such laboratories as those of St. Bartholomew's Hospital and Guy's Hospital, and Charing Cross Hospital.

5815. At any one of those institutions or laboratories are there lectures in any way identical with those which the College of Chemistry supplies?—There is a good deal of similarity in the course of laboratory instruction, although there are points of difference. The lectures at the School of Mines are of a more special character, having a more special bearing upon the future pursuits of the students, and that difference has extended itself also, to some extent, to the practical instruction in the laboratory.

5816. You spoke in one of your answers of dividing the students into three categories, beginners, students of quantitative analysis, and students of research. With regard to beginners, do you think it a desirable thing that the State should be called upon to interfere in the earlier part of the education of scientific men, or do you think it might reasonably be expected that the preliminary part of such an education should be completed before the pupil was taken in hand?—I do not think that it is of so much importance that the preliminary training should be taken in hand by the Government as the subsequent and higher training, and more particularly the special training; that is more, I think, a subject for Government interference. My idea of it would be that a selection should be made from the most promising students in the elementary departments of chemistry and the other sciences, and that those students should have facilities for pursuing

the higher branches of science in a Government establishment where some of the cost should be borne by the State.

5817. When you use the word "beginners" I presume that you do so in a relative sense, not as meaning persons who were ignorant of the rudimentary part of the science which they were about to engage in, but rather that they were relatively beginners?—I alluded to their being absolutely beginners. Most of those who come to me are absolutely beginners.

5818. The College of Chemistry stands to the School of Mines in the relation of laboratory, in some measure, does it not?—It does; it is the chemical department of the School of Mines.

5819. In the event of the transfer of the College of Chemistry to South Kensington, for example, the two institutions would have to be brought into much greater proximity than at present, that would be one of the advantages of the removal, would it not?—It would be desirable that the lectures should be all given in the same building or group of buildings, if possible, for there is a good deal of time wasted now in passing from the College of Chemistry to Jermyn Street, and *vice versa*.

5820. (*Mr. Samuelson.*) You would, I presume, except some subjects from that remark, for instance, those for which the illustrations afforded by the Museum of Practical Geology are particularly useful?—Yes. I think I mentioned in my former examination that it would, in my opinion, be better to divide the course of instruction into two or three parts. The instruction given, probably in the first two years of the course, should be given in the central school; the School of Mines in Jermyn Street affords facilities for the special training of a particular class of students who would take their third year's course there; and my impression was that that course could be still given in the School of Mines, but that the first two years' instruction should be given at the central school at South Kensington.

5821. (*Marquis of Lansdowne.*) With reference to the direction of the studies which are embraced in a scientific education, do you think that that should be regulated with a view to the development of the arts or merely to giving to the public mind a scientific turn which would enable the arts hereafter to appropriate the most conspicuous students?—I think the object ought to be two-fold, it ought to be first to stimulate the applications of science to the arts with a view to increasing the number of those applications; and secondly (and perhaps principally), to enable scientific talent, in the lower ranks of life more especially, to have an opportunity of developing itself, to give men like Faraday in early life, for instance, an opportunity of completing their scientific training at the expense of the State. Those men are few in number, and would therefore not cost any inordinate sum, but they are of priceless value to the State, and add great additional wealth and power to the State by their subsequent discoveries, and their education may, I think, therefore, fairly be paid for out of the resources of the State.

5822. In the schedule of students who have distinguished themselves, am I right in thinking that a very large majority have distinguished themselves as chemists in rather the technical line of the science, if I may use the expression, because I observe that there are a great number of manufacturing chemists, pharmaceutical chemists, chemical manufacturers, and so forth, as compared with persons who have become engaged in scientific education?—That is so. An analysis of the schedule which I have put in shows that 45 professors and teachers, and eight amateur chemists, have emanated from the college, whilst the remaining of the 315 students whose subsequent history has been traced, have devoted themselves chiefly to technical pursuits.

5823. (*Dr. Sharpey.*) Could you state the aggregate amount of fees per annum received from the pupils in the School of Chemistry in the laboratory?—The gross aggregate amount varies from 1,018*l.* to 1,383*l.*



5824. Are there any analyses executed there for private account?—There are a few, but not many.

5825. And those are paid for, are they not, by those who desire them?—Yes, those are paid for by the persons who wish to have them executed.

5826. To whom does that payment go?—That goes to the professor entirely, as he pays the salary of the assistant who executes them, as well as the cost of chemicals and apparatus.

5827. Is the amount of that important, or is it insignificant?—That is an insignificant part of the income.

5828. If I understand you rightly, the State supplies the rent of the building, the fittings, the apparatus, the fuel, and the gas?—As to the apparatus, the State supplies only the fitted apparatus, such as furnaces, benches, and cupboards, and which might perhaps be more appropriately described as fittings only, because the apparatus proper is provided by the professor. The library has also been paid for by the students and professor.

5829. Do they pay two assistants?—No; they only pay one assistant, the lecture class assistant. I am now speaking, of course, of the school, to which alone I understand your question refers; but I may add that the professor of chemistry to the School of Mines also holds the appointment of analyst to the Geological Survey. For this he receives a salary of 100*l.* per annum, and 50*l.* per annum for an assistant and other expenses.

5830. Have you ever calculated what is the expense per student on the whole, including the fees, and including the part paid by the State?—No; I have not calculated that out as regards the cost per student, but about a year ago I made a comparative calculation for Mr. Samuelson, in which I took Owens College at Manchester as an institution that I knew all about, having been a professor there, in comparison with the College of Chemistry, and I found that whilst we had a considerably larger number of students, reckoning in both cases the evening students under instruction, our expenses, including scholarships, exhibitions, and salaries, scarcely exceeded those at Owens College. The aggregate expenses of the School of Mines, as compared with Owens College, exceeded the latter by only a few pounds, and, as in Manchester the expense of several things, such as fuel, is much less than in London, I believe that shows that the establishment is carried on with great economy, because I look upon Owens College as a very economical institution. They have always been short of funds, and have done everything in the cheapest way. Nevertheless, they pay their professors considerably more than the Government do. Their fee to professors is 350*l.*, the Government retaining fee being 200*l.* 200*l.* is my stipend.

5831. Are any of the pupils, or any considerable number of those who pass through your college, destined for employment in any branch of the public service?—Yes; a certain number of students from the Inland Revenue office are destined for service in the Inland Revenue. They however attend the lectures only, and they get their practical instruction at the Inland Revenue laboratory. Then I may mention that a year or two ago we had a number of men who were training for employment on the staff of the Indian telegraph service.

5832. The Government now contemplate having an establishment of their own for teaching telegraphy, do they not?—Yes, for teaching engineering generally.

5833. That is decided upon, apparently?—Yes; I believe so.

5834. Looking to the list with which you have furnished the Commission, it would seem, would it not, that the greater number are engaged in private occupations?—Yes, the great majority; I may say that a not inconsiderable number are sent to the College of Chemistry with the intention of being employed afterwards in some chemical manufactory, or in some technical factory. Brewers especially keep almost a constant stream of students passing through the College of Chemistry. They employ a considerable number of

chemists in their breweries; some of them have two in the same brewery, and they pay them large salaries. For instance, there is one gentleman who was an assistant in the College of Chemistry not many years ago who now receives 700*l.* a year salary in a Burton brewery.

5835. Seeing that those employments are so lucrative, do you not think that such a fee might be charged to such students for instruction in the laboratory as would defray the expense of the laboratory, without requiring the support of the State?—I find that the fees as they are at present, and which were found not to be sufficient to support the laboratory before it became a State institution, are complained of as very heavy by the parents who have to pay them. There is of course in most cases an uncertainty as to a man's getting such a position at all, when he leaves the College of Chemistry; students frequently have to wait for a year or two before they get any position after leaving the College of Chemistry, and even then perhaps they receive for several years not more than 60*l.* to 100*l.* per annum. This is especially the case with men who wish to cultivate the higher branches of the science. It is not like the medical profession, where a man can go into practice at once when he has taken his degree.

5836. Apart from the employment of the College of Chemistry in the training of science teachers, what other reason is there for having converted it into a Government institution?—I believe that the reason, as it appears from the letters that passed on the subject for assimilating the Royal College of Chemistry with the School of Mines, was, that there was not sufficient room in the School of Mines in Jermyn Street for the chemical classes there; they were compelled to go elsewhere, and the College of Chemistry existing at the time, and being in an embarrassed condition, probably the thought suggested itself, that the attachment of the college to the Government school would be the best mode out of the difficulty for both parties.

5837. It was not able to maintain itself as a self-supporting institution by the subscriptions of those who originally established it?—No, it was not, although it was continually well filled with students paying those heavy fees; nevertheless, it could not be made a self-supporting institution.

5838. But it is now grown into a more important establishment than a mere part of the School of Mines, is it not?—No, I do not know that it is.

5839. I mean that apart from the instruction of the pupils of the School of Mines, there is a great deal of instruction given in the College of Chemistry quite independently of that, is there not?—I should think that there are very few students who work in the laboratory who are not actually entered in Jermyn Street and pay fees for lectures in Jermyn Street. There are a few who do not attend lectures, and who will consequently not pass through the books in Jermyn Street, and who will pay their fees directly to my secretary at the College of Chemistry; but still those men are regarded as occasional pupils in the School of Mines, inasmuch as the college is the chemical department of the school; it is merely by accident that it is separated from Jermyn Street.

5840. Does that apply to the list of students who have distinguished themselves which you have handed in to the Commission?—Yes, it does, after the union of the college with the School of Mines. Of course that list goes back to the beginning of the college, and some of the earlier men were instructed there before the college was transferred.

5841. Speaking of the want of room, do you give the pupils of the School of Mines a preference?—Yes, we give the preference to the pupils of the School of Mines and to the royal exhibitioners. There are three royal exhibitioners that I receive and give chemical instruction to at half fees, and they have also the preference.

5842. What would be the nature of the instruction that you would propose to give to the science teachers? Would it simply be instruction in chemistry on the

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same plan as to ordinary students, or would it have any special relation to their future duties as teachers?—At first it would probably be necessary to give both kinds of instruction, inasmuch as many of the teachers who would come for this instruction would be practically ignorant of chemistry altogether, and the first part of the course would be very similar to that which would be given to students in chemistry who were only beginners.

5843. Whilst they were going through this nine months' course in the College of Chemistry, they could be receiving instruction in other institutions on other subjects, could they not, in physics, for example, or natural history?—Yes.

5844. There would be quite time for that during the nine months, I suppose?—There would not be time for any other practical instruction, but for a certain amount of lecture instruction, not exceeding as a rule an hour a day, or two hours a day at the maximum.

5845. Would the teachers be expected to pay a fee, or would it be quite gratuitous?—I am afraid it would have to be gratuitous at first, because they could not afford to pay.

5846. What security would you have if you give gratuitous teaching to those gentlemen for nine months in practical chemistry, that they would not go afterwards into trade; for instance, they might be induced to go into some of those manufacturing establishments that you spoke of?—You can have no absolute security. But they could enter into an agreement to serve for a certain number of years, and they might be refused admittance without entering into such an agreement.

5847. If I understand you rightly, supposing the College of Chemistry were to be so largely devoted to a training college for teachers, that would constitute the most important function of the College of Chemistry henceforth?—Yes, I think that would be so, and in affording facilities for the carrying on of original research by people who should in certain cases be aided by the State in doing that, and in other cases should pay for it.

5848. (*Mr. Samuelson.*) In the event of some of the classes now held in Jermyn Street being removed to South Kensington, and the College of Chemistry being also removed to the new laboratories, you would contemplate, would you not, the connexion between the Geological Survey and the Mining School ceasing to exist?—Yes. I cannot myself see any advantage in the two continuing to be connected. I confess that I am not very well acquainted with the connexion which does exist between them. My own impression was that they merely happened to be in the same building.

5849. Though they have the same chief?—Yes.

5850. Then, in the event of the two institutions being separated, what is the nature of the government that you would contemplate for the new schools which we will call the training schools?—A principal or a director, and a senate or a council of teachers would be required; very much the same kind of government that there is now in the School of Mines, which appears to me to work very well.

5851. A dean and a council?—Yes.

5852. The School of Mines up to the present time has been practically governed, has it not, by such a council?—It has. Of course the decisions of this council are subject to the approval of the Committee of Council on Education, but I am not aware of any question which has arisen where the decision of the council has been reversed, except in cases where the council proposed to spend more money.

5853. And the proceedings of that council have generally been very harmonious, have they not?—Very much so indeed.

5854. (*Professor Huxley.*) Do you consider that any one can be really competent to teach even the most elementary chemistry in elementary schools, without having had some such training as that which you contemplated under the nine months?—Decidedly not. In my opinion it requires almost a better training to teach the most elementary parts of chemistry to boys who know nothing about it, than it does to give in-

struction to others who are better acquainted with the subject.

5855. I apprehend that if the teaching of elementary science in the country is to be what it ought to be, you would like to hear of the elementary schoolmaster who teaches science to them, having had something equivalent to that nine months' practical training?—I should like it, certainly.

5856. (*Sir J. P. Kay-Shuttleworth.*) Will you describe what amount of chemical knowledge you think could be given in an elementary day school, supposing that the age were extended from what it is now, an average of 11, to an average of 13?—I think that a descriptive acquaintance with the chief chemical elements and their most important compounds, in the first place, might be taught to boys under 13, and also a few simple chemical experimental reactions in the laboratory, not many.

5857. Would you for that purpose attach a laboratory to every elementary school, or to the chief elementary school?—I would have what I suppose would require to be called a laboratory; it ought to be a room in which some six or eight people could sit at the same time opposite a bench where those experiments could be performed; it need only be of a very simple description. I have no doubt that a very few experiments made by the pupil himself under these circumstances, would serve to fix the book instruction and the descriptive instruction in his mind.

5858. What time per week would you give to the instruction in chemistry?—I think for that purpose you might give altogether about two hours a week.

5859. From two hours a week given to a child under 13, do you think that you would be able to derive any very appreciable result?—I have found it to be so to a very marked extent in my own experience; but then I am afraid my own experience would not quite coincide with that of an average day school. At Queenwood College I instructed boys from 11 to 13, who made remarkable progress in the elementary department of chemistry, to which I have just now referred.

5860. You are probably aware that up to this time the number of children who pass up to the fourth standard of the Committee of Council on Education, which comprises only a certain amount of reading, writing, and arithmetic, is comparatively small?—Yes; but I hope that under our new Education Act that will soon be remedied.

5861. Do not you observe that there are two obstacles in the way; first, the extension of the time from 11 to 13, and also a very considerable advance in the intelligence and attainments of the school, which changes I apprehend would require no small space of time in the history of the civilisation of this country to accomplish?—I should think that five or ten years ought to make a good deal of difference in that respect.

5862. Do you mean as to the average period of attendance on school?—Yes, I should think so, if the School Boards do their duty.

5863. (*Professor Huxley.*) Do you happen to have seen any of the handbooks for the primary schools which are published in Germany; I mean those handbooks which are used in the schools for the elementary teaching of science?—No, I have not.

5864. There are some very excellent works, both German and Swiss, of that kind, and the curriculum of instruction, which embraces a good deal not only of elementary natural history, but of elementary physics and elementary chemistry in those handbooks which are actually worked by practical men, is laid down at two hours a week, which is exactly what you are recommending now, and that is actually in practice in Württemberg, in Switzerland, and to a certain extent in Prussia and Germany at the present moment, so that the thing can be done?—I have not a doubt that it could be done, if effective teachers were there to do it.

5865. Is it not the case that from the method which has been pursued by elementary teachers in this



country they are almost entirely incompetent to teach science, and that they have not understood in the least degree what the teaching of science is?—Certainly, that is the case.

5866. (*Chairman.*) Are you of opinion that scientific research in Great Britain makes as much progress as in France or Germany?—No, I am convinced that it does not by any means make such rapid progress in Great Britain as it does either in Germany or in France. A year or two ago I took the trouble to look out in regard to chemistry the number of original investigations made in each country during one year, and with your Grace's permission I will put very shortly the result of that inquiry before the Commission. In the year 1866, which was the year I inquired, 1,273 papers were published by 805 chemists, being at the average rate of 1·58 paper for each investigator. Of these, Germany contributed 445 authors and 777 papers, or 1·75 paper to each author. France 170 authors and 245 papers, or 1·44 paper to each author. The United Kingdom, 97 authors and 127 papers, or 1·31 paper to each author, whilst other countries furnished 93 authors and 124 papers, or 1·33 paper for each author. I may mention, however, speaking exclusively of chemistry, for I have not gone into the other sciences, that as far as research in Great Britain depends upon our own scientific training, our case is very much worse than appears from this comparison, because a large proportion of those papers contributed by the United Kingdom, were the work of Germans residing in this country, but who had not been trained in this country.

5867. To what causes do you attribute our inferiority in this respect?—In my opinion the cause of this slow progress of original research here depends in the first place upon the want of suitable buildings for conducting the necessary experiments connected with research; secondly, upon the want of funds to defray the expenses of those inquiries, these expenses being sometimes very considerable; but thirdly, and chiefly, I believe that the cause lies in the entire non-recognition of original research by any of our Universities. Even the University of London, which has been foremost in advancing instruction in experimental science, gives its highest degree in science without requiring any proof that the candidate possesses the faculty of original research, or is competent to extend the boundaries of the science in which he graduates. I consider that this circumstance is the one which chiefly affects the progress of research in this country, because if we inquire into the origin of those numerous memoirs upon original investigations that come from Germany, we find that a considerable proportion of them are investigations made by men who are going in for their science degrees, and who are compelled in the first instance to make those investigations, and they attain by that means the faculty and liking for original research, and frequently follow it out afterwards; so that a considerable proportion of the papers themselves are contributed in the first place by those men going in for degrees, and a considerable proportion of the remainder are obtained, I believe, through the influence of this previous training in research upon the men who have taken the degrees. Further, the entire ignoring of research in the giving of degrees in this country diverts also, or has a tendency to divert, the attention of the professors and teachers in this country from original research. They have not to take it into their consideration in the training of their students—they have not to devise, as is the case in Germany, suitable subjects for research to be pursued by their students; and thus their attention is, as it were, taken away entirely from this highest field of science. And indeed, if they themselves devote some of their time to original research, it almost appears to them to be a neglect of their class duties, because their class duties do not require it. Their students are to be trained for subjects which are foreign to original research; they are to be trained chiefly in subjects that are to be taught by lectures, and by what I should call “descriptive” as distinguished from

“experimental” or “practical” teaching; and consequently I think that in both ways,—both by not bringing students into contact with original experimental work, and by diverting the attention of the teachers and professors in this country from such work, great damage is done to the progress of investigation in Great Britain by the attitude of our Universities.

5868. Are you able to say whether the average value of the papers produced as qualifications for degrees in Germany is considerable?—It is considerable. It varies of course; but in the better Universities, I may say in all Prussian Universities, the paper must be of importance, or the candidate will not be admitted to examination, the course being this,—that in applying to be examined for the degree of doctor of philosophy in those Universities, the candidate must hand in a manuscript memoir describing the results of an original research conducted by himself. This is carefully examined by the faculty, and if found of sufficient importance the candidate is admitted to examination, but not otherwise. More candidates in the University that I am particularly acquainted with, namely, the University of Marburg, are rejected on account of the insufficiency of the value of the research, than from failure in the examination afterwards.

5869. Would you like to see some evidence of the power of conducting original research made indispensable for scientific degrees in this country?—I should; because I am convinced that you have only to set such a thing before students, in order to get them to do it. I have found that the work which a student will perform depends very much upon what is required of him in his examinations. When I went to the College of Chemistry I found that the highest class in the annual examinations could be attained there without the candidate being acquainted with quantitative analysis, and I found that many of the better students had completed their course of qualitative analysis by the end of about six or seven months, so that they had two or three months left, of the nine months' course, to devote to quantitative analysis,—to this higher branch of chemistry. I advised them to do this, and they said, What will be the value of it in the examination? and I was obliged to confess that it would be of no value to them. Then they said, We would rather not do it. Now that has been since altered, and each year, every student of any capacity at all, passes through a course of quantitative analysis; and this is not difficult, because it is made essential now to the taking of a first-class certificate in chemistry, and I think if one could get those men to work a little longer, and if original research were made essential to the taking of a certificate, it could be got out of them just in the same way; not in nine months, but if an additional six or nine months could be added to that, it could be accomplished without difficulty.

5870. (*Professor Huxley.*) You would ask that as evidence of original power in the case of the highest degree?—Yes, for the highest degree only.

5871. You would not ask it for the bachelorship?—No, for the bachelorship I would not, but I would also like to see the final examination on the giving of the bachelor's degree of science in the London University made more dependent upon experimental knowledge than it is at present. I have had repeated instances, and more especially two which occurred the other day, of gentlemen who had taken the degree of bachelor of science, and who were really attached to science, and wished to pursue it, coming to me, desiring to become assistants in a chemical laboratory, or a physiological laboratory, or elsewhere, and when I talked to them about this, I found that they had never made an experiment in their lives, and that they would be utterly worthless in a laboratory. There was a gentleman, a bachelor of science, who came to me the other day wishing to enter the College of Chemistry as an assistant, and I would gladly have aided him if possible in that way, but he would have had to begin there as a student from the beginning, for he knew nothing of experimental

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chemistry. The bachelor of science examination is a very stringent one, and a very good one so far as the theoretical departments are concerned, but I should like to see more experimental knowledge required.

5872. (*Dr. Sharpey.*) Are you aware that there is a practical examination for a medical degree which extends over a considerable time?—Yes, there is also a practical examination, I believe, in the doctorate examination, but it is not of a nature to elicit skill in original research.

5873. (*Chairman.*) Are both Germany and France better supplied with good laboratories than England?—Very much better.

5874. Are the laboratories themselves and the funds for maintaining them provided by the State?—They are.

5875. Do you think it at all likely that this country could be provided with what you would consider a sufficient number of good laboratories without assistance from the Government?—I do not. I believe it would be impossible to keep them up in an efficient condition owing to the impossibility of keeping up subscriptions for such purposes. That I may say has been the case with Owens College. At the present moment the funds are not sufficient to complete the building of that college. Although they have used every effort, and have got very large subscriptions at Manchester, still it is not sufficient to build a college suitable for the present wants of Manchester. But I should not think it desirable that the Government in such cases should assist with the building, the State aid should rather be given, as far as possible, in the shape of salaries to the professors and assistants, and perhaps in grants towards the expense of original research. It is possible to get sufficient money to build a laboratory or a college by great efforts, on the spur of the moment, but you cannot keep up a regular income in that way, and it is a regular income that is wanted in such a place, because institutions for training students in experimental science cannot be made self-supporting.

5876. (*Professor Smith.*) The doctorate dissertations in Germany to which you referred are usually printed, are they not?—They are printed after they have been circulated amongst the members of the faculty and they appear in the scientific journals as ordinary memoirs.

5877. It is not obligatory, is it, upon the candidate for the doctorate degree that those dissertations should be printed?—I do not think it is, but I never knew a case in which such a dissertation was not printed. In some cases the University requires that it shall be printed for circulation amongst the members of the University, but it certainly does not require that it shall be printed in a scientific journal.

5878. At any rate if not absolutely required it is the almost universal practice that it does appear in print?—Yes, the account of every scientific investigation always appears in a scientific journal after being handed in as a dissertation by the candidate.

5879. Is any complaint ever made that those doctorate dissertations are not purely the work of the candidates themselves?—I have never heard of such a complaint or of such a case occurring in my own experience.

5880. With regard to the circumstances of this country in the older Universities where a fellowship is given away which is of great pecuniary value, and where it would be very desirable so to give away fellowships as to encourage the spirit of scientific research, do you think that it would be possible to give them away upon the evidence supplied by such dissertations, and do you suppose that if they were given away in this manner, the public would have any confidence in the fairness and justice of the decision?—I think with proper safeguards they ought to have. It is true that the conditions of the giving of a fellowship in this way are somewhat different from those which obtain in the giving of a degree in a German University, where the experimental work is usually done under the eye of a professor in the University, and consequently he can vouch for its being

actually done by the candidate; but if you were to require the testimony of say two or three well-known men of science or of some responsible parties that this work had really been done by the candidate for the fellowship, I do not see that you could have a greater security than that, or that any greater security ought to be required. A candidate would find it very difficult to meet with a person qualified to make a sufficiently good original research who would sell his work for that immoral purpose. On the other hand, I have heard of mere examinations being passed by proxy.

5881. I can see that in the case of the experimental sciences, that would clearly be a very strong security that could be obtained, but in some of the more abstract branches of science the difficulty would make itself felt, would it not?—Yes; the difficulty would be greater there no doubt, it is not felt in the German Universities (at least not in the smaller ones, I do not know how it may be in Berlin), for the reason that the candidate is well known to the professor of the department of science in which he makes the investigation, his progress has been watched probably all through it, and there is but little chance of anything surreptitious being brought in.

5882. Does any other way occur to you besides that system of dissertations, or the work embodied in the dissertation by which the University examinations could be given this tendency to encourage a spirit of scientific research in the candidates?—No, I cannot conceive of any other method than that of actually making the candidate work out such research, and I may mention that this method has been tried; that it was instituted in fact at my recommendation at Owens College about the year 1853, and has been in operation there ever since. The Dalton scholarships are given for original research, and they have called forth several investigations in that laboratory, not so many as might have been anticipated, perhaps, for the scholarship has not been taken on several occasions; but still they have called forth several original investigations of considerable merit.

5883. (*Mr. Samuelson.*) Setting aside the interests of science, what would be your expectation under equal circumstances otherwise, in reference to two countries, in one of which scientific research was neglected, whilst in the other it was pursued with considerable vigour, with regard to the progress of the arts and of manufactures?—In my opinion there could not be any doubt but that the nation which neglected science must suffer in the end, because although it could buy scientific inventions from the other country, yet still it would always be behind, as it were, in the market; it would have to follow the lead of the other country, which I imagine would be a commercial disadvantage.

5884. Might it not also be the case that the appreciation of the commercial value of scientific inventions would be very much more uncertain in the one country than in the other?—Yes. It is also much more difficult to establish manufactures upon new inventions in a country which neglects science, because you cannot have either workpeople or managers competent to conduct those processes which depend upon scientific principles.

5885. People might pay large sums for what was worthless, and neglect that which was of great value?—They might.

5886. (*Professor Stokes.*) In the foreign Universities that you refer to, is the evidence of original research required only for the highest degree; is there a lower degree for which it is not required?—I think there is no lower degree. In most of the Universities there is only the one degree. I believe in some of the German Universities there is a bachelorship of philosophy, but it is very rarely taken. I do not know an instance of its being taken, but I have heard that there is such a degree at some Universities; it is a lower one than that of doctor of philosophy.

5887. And not a necessary stepping stone to the higher degree?—No.

5888. (*Dr. Sharpey.*) Does your statement with



reference to the terms upon which they grant degrees in philosophy apply to the Universities of Germany generally; for example, to the great Universities of Berlin and Vienna, or to some of the smaller Universities only?—It applies, I believe, to all the Prussian Universities, and it applies to the Universities of Marburg and Leipsic, the first of which is now Prussian, but was not a little while ago; it applied to Marburg before it became Prussian.

5889. Is not a degree in philosophy granted on other grounds besides science, for example, for mental philosophy?—Yes, but there must be a dissertation in any case. Moreover, he must present himself for examination in three sciences or subjects, being collaterally examined in mathematics, and to some extent in classics. If he takes chemistry he is subject to some examination in mineralogy whether he takes that subject or not; but supposing he takes chemistry and physics, and, we will say, botany, he will be examined in those three sciences, but he may select one of them as the principal one, or he may say, I will be examined equally in all, as he pleases, but in the science in which he is examined principally, if he selects one of them, his dissertation must be upon some investigation connected with that science.

5890. You spoke of the want of buildings adapted for scientific research, have you considered any scheme for establishing such buildings, and on what footing they should be placed, with a view to their being accessible to those desiring to use them?—Yes. Some time ago I gave considerable attention to the possibility of establishing such buildings as separate institutions, but they are without precedent. I know of no such establishments on the Continent, but I think it not unlikely that they might aid in the promotion of scientific research to a great extent. My idea was that, confining myself to chemistry, though of course the same would apply to the other practical sciences, a building should be provided with all the best appliances for conducting chemical research, and that there should be special benches, or, it may be, even special small rooms in that building, apportioned to individuals who should enter there as original investigators. There are some men in this country who have leisure, and also a desire to pursue investigations of this kind, and I imagine, if facilities of that description were offered to them, a good deal of research would be obtained in that way. Those gentlemen should have assigned to them one of those benches, or one of those rooms, with the use of all the instruments provided in the building, and they should of course pay for that a sufficient sum to cover the current expenses at all events; but it would, I think, be desirable to provide a certain number of those benches or rooms, which should be assigned to people who could not afford to

pay for them; and the expenses of those particular benches and rooms should be defrayed by the State, either partly or wholly.

5891. Would those persons who would be favoured in that way bring evidence of special fitness to undertake such researches?—Certainly that ought to be required, because it would be throwing the rooms away in giving them to any who imagined that they could, without any training, make a research.

5892. And of course the expensive apparatus would be provided?—Yes. Apparatus of a general nature would be provided; special apparatus is almost always required in individual researches, and that could be obtained probably from other sources, as, for instance, from the Government Grant Fund, which is administered by the Royal Society.

5893. But there is always a certain amount of general apparatus necessary, such as instruments of precision, measuring instruments, and things of that sort?—Yes. It may be said that individuals who could afford to pay for one of those benches or rooms, could well afford to carry on those researches in their own houses, and why should they not do so? But the answer to that is, that in the case of chemistry it is very inconvenient to have a laboratory in your own house, inconvenient to your family, inconvenient to your neighbours, and it would not be permitted, in fact, in many districts that those operations should be carried on in a private house, so that they scarcely can be carried on unless there are some public institutions of some kind to prosecute them in.

5894. You would propose that more funds should be supplied in the way of public money for carrying on scientific inquiries. Do you think that at present they are inadequate?—No, I do not. I think that the fund at present supplied is sufficient. I speak under correction; but a ten-years' experience of the administration of the Government Grant Fund has given me the impression that it is ample for the applications which are made for it at the present moment, therefore I believe that what in the first instance is wanted is, the recognition of research by the Universities in the giving of degrees, and then it would doubtless be necessary to increase that fund.

5895. You consider it more important to begin with the former?—Yes. In my opinion the mere granting of more money would have very little effect in promoting research.

5896. Do you think that a system of competitive examinations carried to an extreme degree is favourable to original research?—No, I do not. As they are carried on now I think that they are decidedly inimical to original research. So far as I know there are no competitive examinations in Germany.

The witness withdrew.

JOHN FREDERICK ISELIN, Esq., M.A., examined.

5897. (*Sir J. P. Kay-Shuttleworth.*) We understand that you are Inspector of Science Schools under the Science and Art Department of South Kensington?—Yes, I am.

5898. Will you be good enough to describe to the Commission generally what your duties are?—In the first place my duties are those of inspection wholly, as distinguished from examination. I go down to a school, either one of science or art, and by previous notice to the committee I give them intimation of my coming. I then, generally speaking, hold a meeting of the committee before the school commences, or after the classes have finished, and go with the members into certain of the details of the school, the class of pupils who attend, and the instruction that is given, and observe whether they take any interest in the school themselves (which, by the bye, I am sorry to say is not very often the case); and generally whether the regulations of the Department are properly carried out. Then I attend the classes, and form, as far as I can, an opinion of the manner in which the instruction is given, either by myself questioning where I can do so, or by listening to

the teacher giving his instruction, and observing how he demonstrates and how he uses his apparatus. And then I make my report upon that to the Department. I may say, perhaps, that my forming an opinion of the instruction is confined entirely to a science school. As regards the art schools, I form no such opinion: there is a special inspector who goes for that purpose.

5899. Your first and principal duties are those of inspection as distinguished from examination?—Yes.

5900. You observe what is done in the school, the manner and degree of attention paid by the pupils, and the method of teaching, and you form an opinion upon the efficiency of the instruction of the master from observing him teach?—Yes.

5901. And it is in exceptional cases that you yourself examine the school, so as to obtain an accurate knowledge of what the pupils have attained?—When I drew a distinction between inspection and examination, I was thinking of the duty rather of the Whitehall Inspectors, which is chiefly that of examination. Payments on results are made upon their reports. No payments on results are made upon my reports under

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any circumstances, and when I examine boys of whatever class they may consist, it is rather for the purpose of forming an opinion of the knowledge they have acquired, so that I may be able to report whether I consider that the school is well taught or not.

5902. Do you have to examine the school for that purpose?—For that purpose I do,—not invariably. I do not think I should do it in the case of an adult class; perhaps they might not like it in such cases as that.

5903. Are those schools which you visit chiefly held in the daytime, or in the evening?—They are chiefly held in the evening; with very few exceptions, science schools are held in the evening.

5904. Are they attached to elementary day schools, or to mechanics' institutions, or to what institutions?—In some cases they are attached to elementary day schools, in some cases to elementary schools not connected with the Whitehall Department, and in some cases to mechanics' institutes, working men's institutes, and clubs.

5905. Are there amongst those any classes of teachers under instruction in the country?—Yes, there are. There are schoolmasters' classes to instruct in the teaching of science. As far as I know, there are classes at Manchester of that character, and there are classes at Leeds, and I think there are classes at Burnley, although I have not had an opportunity of seeing them. I think those are all that I know of.

5906. Taking any subject of experimental science,—for example, chemistry,—in what proportion of those classes do you find, in the first place, any adequate apparatus for the instruction in elementary chemistry?—Very much more so in the last year or two than there was formerly. The instruction which was given to the teachers in London, I think, has been very beneficial in that respect, in showing the teachers how necessary it is to demonstrate, in order to give their pupils a clear idea of experimental science.

5907. And would the proportion of one-third of the teachers be competent, and be supplied with sufficient apparatus to give such demonstrations?—Without going into details, and making up the account for myself, I should be unwilling to fix any decided proportion, but as far as my recollection will serve, I think I should be inclined to say more than one-third would be the proportion certainly; I think, decidedly, more like two-thirds than one-third.

5908. Taking the subject of experimental physics, what would you say would be the proportion of teachers competent to give experimental illustrations, and having sufficient apparatus?—There is a distinction that I draw, that a certain number may be capable of giving the instruction, but have not money or conveniences for supplying themselves with sufficient apparatus; but of the two combined, the proportion is not so large as in chemistry; and, as I said before, without going into details, and looking at reports, I should not like to fix any proportion.

5909. Does your inspection extend to classes in sciences of observation, such as botany?—Yes.

5910. Have you found that the classes of instruction in botany have been held in the winter or the summer?—They are generally held in the summer; but there are so few of them and they are so very widely scattered, that so far as my memory serves, I think I may say that they are nearly always held in summer. The masters are in the habit of giving them lectures during the winter, and in the early spring and summer months they take their pupils out into the fields.

5911. Is that often the case?—Yes, that is very often so. But the number of classes is so few that it is only a very good teacher that ever takes up botany.

5912. As respects instruction in geology, have you found that the instruction has been illustrated by specimens?—No, not so much as could be wished I think. In fact I had a very remarkable instance in Ireland of a lad who was a teacher, who had taken the silver medal for geology, and yet in the course of

conversation with him I understood him to say that he had never seen a fossil or a rock in his life.

5913. Have you observed whether it has been the custom for the teacher to avail himself of any natural geological phenomena in the neighbourhood for the purpose of illustrating his instruction?—One or two cases I think I have seen of that, but, as in botany, the number of classes in geology is limited. Certainly in some cases I have seen that there were very good teachers who have been very careful in that respect, and if there were a remarkable section in their neighbourhood they would be very careful to examine it.

5914. Or if there were remarkable phenomena, such as a great fault, or good illustration of the erosive action of water?—Yes, in fact I may say that I have obtained a certain amount of geological information on the geological formation of different parts of the country by conversation with teachers.

5915. With regard to those men who are instructors in geology, do you observe that they form for themselves collections of fossils?—No, I have never observed that; and in conversation with them I have generally advised them to the contrary. It seems to me that in nearly every large town there is or should be a collection, which would be very much superior to any private collection that a teacher could form for himself; and if he wishes any for his class he ought to get it by purchase, and have a typical collection.

5916. But if he were in the country and remote from such a collection, as is frequently the case (I am speaking of the populous manufacturing districts), would you not encourage him to form a collection of his own?—If there was really no means of access to a good museum, of course that would be the only means he would have.

5917. Generally speaking, would your impression be that the science teachers at present derive their knowledge very much from books, and not to a very great extent either from opportunities of manipulation or observation, or from any other sources than what are afforded by the illustrations of books?—Yes, I think so, up to within the last two years. The system of bringing them up and giving them courses of lectures in London has been a very great benefit to them. I have had many occasions of noticing it in all the experimental sciences.

5918. You would think it desirable to extend considerably the opportunities for such instruction in manipulation and in the knowledge of specimens, by facilities like those which have already been afforded in London?—Yes, certainly.

5919. Without that would you expect that all the benefit which you hoped to be obtained by the system of elementary scientific instruction would result from it?—No, I hardly think they would.

5920. From, I will not say mere book instruction, but instruction which is chiefly derived on the part of the teacher from books, and communicated either by oral or book instruction to a school upon experimental sciences and sciences of observation, you could not expect even that the proper faculties which those sciences are best calculated to train, would be developed?—No, I think not.

5921. Take for example the instruction in botany, without the facilities and frequent use of opportunities for observation, some of the very best results of mental training could not be obtained?—Certainly not. I think, perhaps, there is one distinction to be drawn, and that is between classes in elementary schools and adult classes in evening schools. There would not be the same amount of demonstration and of apparatus generally necessary in elementary schools that there would be in an adult class, because I apprehend that the adult class would learn more for the purpose of applying their science, than an elementary class would.

5922. Taking the average capacity and state of instruction of the children who remained to the ripest age yet attained in elementary schools, and supposing that even that age were raised beyond the present level up to that of 13 or 14, will you describe to the Commission



what you would conceive to be the best form and the proper limits of elementary instruction in science in an elementary day school, taking everything into account?—That would depend a great deal upon the subjects that were chosen, and also, I think, upon the capacity of the master for instructing in them; but the sciences which are so experimental and so dependent upon demonstration would hardly be fitted for an elementary school. I should rather recommend such a subject as physical geography, which is one which does not require experimental demonstration and would give rather general notions than any fixed ones. And perhaps another, although it would require a certain amount of demonstration, would be animal physiology, but then the knowledge of the functions of the body, and of the laws of health and disease dependent on them is so important to the lower classes, and the science itself is so beneficial in correcting popular errors, that I would strongly recommend animal physiology as subject of study in an elementary school. I may be allowed perhaps to draw the attention of the Commission to what I conceive to be greatly needed in our primary schools, and that is, a knowledge of elementary mathematics, understanding under that some notion of geometry, and of the higher principles of arithmetic. An attainment of the former I despair of while Euclid is retained as a text book in our secondary schools. But I do think that much more attention might be paid to arithmetic. No science can be studied to the most limited extent without the capability of working with decimals, and yet how few are there of the boys who leave our national schools who can attempt the easiest problem depending on decimals for its solution.

5923. (*Mr. Samuelson.*) How many schools do you inspect in the course of the winter?—I suppose that personally I should inspect about 50 or 60 science and art schools. I have the art schools as well.

5924. Then is 50 or 60 the total number of schools inspected by you in the session?—Sometimes more; I have inspected 100, which would be the maximum. We carry on our inspection during the five or six months, from the commencement of October to the end of May.

5925. Your first duty, I presume, is to ascertain that the regulations of the Department are complied with?—Yes.

5926. Do you find that to be generally the case?—Yes; I think as a general rule they are carried out.

5927. That refers to the period of the examination?—No, I am speaking now mainly of inspection. The inspection and the examination would be something different.

5928. You also examine those schools when you have time?—Yes; in the manner I described just now.

5929. Will you state a little more precisely what your mode of proceeding is?—As I said before I examine the pupils myself, giving them perhaps the answer to a question to write out, and I observe whether their elementary knowledge is sufficient to enable them to take advantage of scientific instruction. Then I ask a boy here or a boy there, questions upon the subject of the question which I have asked; but in other cases, and in adult classes more particularly, I listen to the teacher giving his instruction and perhaps I may ask a question upon the subject of his instruction as he goes on, without interfering with him in any way.

5930. Then at the period of the examinations, what are your duties?—At the period of the examination we go in and visit the schools, and see that the regulations are carried out.

5931. How many of those schools has it been your custom to visit in the course of the season?—The examinations only extend over three weeks in the month of May. It depends upon where I am. If I am in Manchester, or a neighbourhood where there are a great many classes, I may be able to visit three or four in an evening.

5932. About how many would you say you visit in the season in practice?—I should think about 40, perhaps, or between 30 and 40.

5933. How many other gentlemen are there who examine besides yourself?—There are only two of us, who are the permanent inspectors of the Department, and in order to make up for the deficiency of inspectors the officers of the Royal Engineers who are stationed in different parts of the country are to undertake our duties.

5934. Do those officers attend any examinations?—Yes; the same as I do. The difference between the cursory examination I have just described, which is intended only to form a general opinion of the instruction, and the regular examination, which is entirely conducted by papers and under the examiners of the department, must be borne in mind.

5935. I mean that kind of cursory examination of which you have spoken?—I do not think they do anything more than that.

5936. But they do attempt it?—Yes. If I may be allowed to put in the form which we have for making our reports, it may give the Commission an idea of the manner in which the duty is performed.

(The same was delivered in. *Vide Appendix X.*)

5937. (*Dr. Sharpey.*) Do you think that there are a sufficient number of competent science teachers at present throughout the country?—It depends altogether so much upon the demand that it would be difficult to say I think. I know that two or three years ago there was great complaint in Yorkshire of the deficiency of science teachers. They wished to take advantage of the Department's aid to science as much as they could, and they found themselves stopped because of the deficiency referred to; but I believe since then that by the establishment of the masters' classes which I mentioned just now they have succeeded in overcoming that difficulty.

5938. We have had evidence before this Commission that in some cases one teacher had to attend two or three different towns, do you confirm that?—Yes, I know that to be the case. The Department gives peculiar facilities in that direction. In certain outlying villages in the manufacturing districts the travelling expenses of the teachers are paid.

5939. Have you considered what would be the most satisfactory way of providing teachers of science in schools?—With regard to merely elementary instruction in science, I believe that the Department has hitherto been doing a very good work, but if it was contemplated that the country should supply a more extensive and a higher class of instruction, then I apprehend that it would be necessary to provide some special means for training school teachers either by means of a training college or several training colleges in particular districts.

5940. (*Sir J. P. Kay-Shuttleworth.*) Supposing that a master had the ordinary instruction of a certificated teacher, and he had after that nine months' instruction in a college intended to train scientific teachers, have you at all considered what sphere in the country would be most appropriate to a master so highly instructed, or where he would find employment?—That would altogether depend, I think, upon the subjects which he intended to teach.

5941. Supposing he were instructed in chemistry and experimental physics, what should you say?—As to chemistry and experimental physics he ought, properly speaking, to find means for instruction in those sciences throughout the country, and more especially in the districts where the dyeing and chemical trades are carried on, such as the neighbourhood of Liverpool and Bradford, and Huddersfield.

5942. Would he not probably have to itinerate over a populous district, and teach the schools in the neighbouring towns?—He most likely would, I think.

5943. So that he would come to fulfil some such function as you are aware is fulfilled by the organising master in East Lancashire?—Yes; I should say very much of that class, except that I hope he would not have to give the elementary instruction which the organising master in East Lancashire has to give.

5944. If the elementary instruction were provided for by the master of the elementary school, and he

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14 Feb. 1871.



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had to superadd to that scientific instruction for adults, his function would be very much similar to that of the organising master in East Lancashire?—Yes. In saying what I have said, my mind has been fixed entirely upon adult evening classes. I think if it is intended that scientific instruction should be introduced into elementary schools, which I would submit is quite a separate question, then the teacher ought not to be compelled to go from one place to another in the way that you speak of.

5945. My question was intended solely to apply to adult schools, whether held in the evening or at any other times; in that case it would be scarcely probable that at first he would obtain, except in the very largest towns, like Manchester, Liverpool, Bradford, Leeds, and so on, sufficient opportunities to teach in one town, and he would probably have to hold classes in several neighbouring comparatively small communities?—I think so. I should like to draw the attention of the Commission very much to the case of the Bristol Trade School. I am surprised to see that the country has not taken up the notion of trade schools to a greater extent than it has. I think that the circumstances of the Bristol Trade School have been over and over again published as far as the department has had the means of doing so, and the attention of the public generally has been drawn to the advantages of such a school; and yet I believe in no case has the example of Bristol been followed, with the exception of the attempts at Worcester, and at Keighley; and the schools in those towns are only just commenced, so that we have scanty means at present of judging of the results. But with those exceptions there have been no attempts to follow the lead of Bristol. The Bristol Trade School was originally founded by the efforts of Canon Moseley, who is still the president of the school, and to a considerable extent, though not quite, it partakes of the character of a *Real or Gewerbe Schule* in Germany. The school is divided into two branches, the elementary branch and the scientific branch; the boys in the elementary branch come as early as eight years of age. They are obliged to pass a certain small examination to show that they possess a sufficient amount of very elementary knowledge, and the boys will pass through that branch with very much the same instruction as is given in the fifth and sixth standards in an ordinary national school. They are then passed on to the scientific branch. In that branch the teachers have laid down as I think a clear distinction between the classes of instruction. They have the mathematical and mechanical sciences on one side and the experimental sciences on the other. All the boys learn both, but still that distinction is kept up by placing the two classes of instruction under different masters. The foundation of the one branch of course is the mathematics, and the boys go on to theoretical and applied mechanics to practical geometry, machine construction, and building construction. That I think would take up the branch on the one side. On the other side, they are taught chemistry, both organic and inorganic, and physics. There are at the present time about 150 boys in the whole school; the fee is only 3*l.* a year. They are principally boys of the upper artisan and smaller tradesman class, and the science portion of the school consisted of about between 60 and 70 pupils at the last date. That school has been able to take advantage of the system of the Department with great convenience to itself. And although there is a certain subscription for the support of the school and the fees of the boys bring in, of course, a certain amount, yet the grants from the Department, I think, last year amounted altogether to over 600*l.*, so that the school is really in receipt of a considerable income, and therefore may be considered to be in a very flourishing condition.

5946. Can you describe to the Commission what is the nature of the payment made by the Department?—The payment made by the Department in that case is just the same as it is in all the other cases. There is no distinction made between them at all. The boys are obliged to pass their examinations, and the payments are made upon the same scale as they are to others.

5947. Has that school had the advantage of those payments from the time of its commencement?—I believe that the school at its original foundation, or some time afterwards, was brought into connexion with the Department when Dr. Lyon Playfair was the secretary for the science division, and at that time it used to receive a fixed annual grant; but when the change in the department came about of paying upon results altogether, the masters of the school with, I think, great readiness, adapted themselves entirely to the new system, and certainly as far as my own knowledge is concerned, and I think they would say themselves, they find it to answer to their satisfaction.

5948. Both as respects the attainments of the boys and their own remuneration?—Yes.

5949. Are you aware that efforts without the aid of the Department have been made in other parts of the country, and which have failed simply for the want of that support?—There was one case I have heard of. There was a school attempted at Sheffield, a private undertaking, I believe, but which did not succeed.

5950. (*Dr. Sharpey.*) What becomes of the boys who are educated at that Bristol school?—A great many of them are apprenticed, and I believe that to a certain extent the committee of the school make themselves parties to the indentures. I think they pay a certain small amount of premium, but I am not quite certain upon that point. They become mostly apprenticed in the engineering works and the sugar refineries in Bristol, and in ship-building, as much as there is in the ship-building line there.

5951. Do they become ordinary workmen?—Yes, they become ordinary workmen, and rise rapidly to foremen.

5952. (*Chairman.*) Is there anything you would like to add to your evidence?—I think there is nothing further. I wish that the Commission could induce the Government to introduce elementary instruction in science into all elementary schools. And my reason for expressing that wish is this: the scheme of the Department, and the syllabus of the sciences in which it holds examinations, have been drawn up mainly with a view to the instruction of adults. But the teachers of national schools, not satisfied with the daily routine of the three R's, to which they are bound down by the Revised Code, have eagerly seized the opportunity to take up some subject which shall possess an interest for their pupils, and perhaps keep them a little longer at school, and so they have applied themselves to some of the science subjects, more particularly to physical geography, which they teach after the regular school hours, and I have been assured over and over again by managers of national schools of the delight and interest which the children manifest in these subjects, and of the beneficial effect the instruction has upon the general efficiency of the school. Now it is extremely difficult to get young children up to the standard of the examination of the department, and hence there arises a tendency to more or less cram. But if a special examination were instituted in science for elementary schools, a previous stage, if I may so describe it, to the present course, and that only in certain subjects, the benefits I conceive would be incalculable. It would have the effect of diminishing the cramming, of which so many complaints are made, and of preparing the pupils for a more serious study of certain branches of science when they leave school.

The witness withdrew.

Adjourned to Friday next at half-past eleven o'clock.



No. 6, Old Palace Yard, Westminster, Friday, 17th February 1871.

PRESENT :

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, BART., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

HENRY COLE, Esq., C.B., and Captain J. F. D. DONNELLY, R.E., further examined.

5953. (*Chairman, to Mr. Cole.*) I believe you have had an opportunity of reading the evidence which you gave to the Commission when you were before it some time ago; and the Commissioners in the first instance would desire to know whether, with respect to your own evidence, or with respect to the evidence of any of the witnesses relating to the Science and Art Department or to schools in the country, there is anything which you would wish to state in the way of correction or addition?—Generally speaking I have nothing to state, excepting that my evidence did not touch an important part of the subject of scientific instruction, namely, that of the encouragement of public museums, which I consider a separate branch altogether; and upon which, if the Commission took evidence, I should desire to speak at length, though not on the present occasion. I was asked by one of the members of the Commission to put in a scheme of a training college, which has been talked about since 1852, and I have sent to the secretary an estimate of the annual expenses of a training college for science teachers, which Captain Donnelly has prepared with much care, and in which I entirely concur. I was asked at another stage of the examination, I think at question 71 in the evidence, what would be the cost for providing structures and buildings, in addition to those already erected, for the purpose of the school of naval architecture and chemical laboratories, which cost 66,000*l.* I estimate that if you wish to do what this estimate points to, about 45,000*l.* altogether would be required, in addition to what has been expended already; that is to say, additional to the 66,000*l.*, which does not provide for a large scheme like this. Of course, so far as the existing buildings go, they provide for the teaching of chemistry and what is embraced by naval architecture and marine engineering; but if you wish to make a comprehensive scheme for a training college, I calculate that an additional sum of 45,000*l.* would be required. I am bound to say that if this Commission should consider it expedient to establish a training college to-morrow morning, or as soon as the present building is roofed in, provisional arrangements could be made to establish a training school pretty much on this basis, but that for the greater part, in the proportion of six to four, it would not have a permanently furnished locale such as is provided for certain sciences by the 66,000*l.* That is all that I wish to add to my evidence. This estimate I will now beg leave to hand in.

(*The witness delivered in the following paper :*)

ESTIMATE of the ANNUAL EXPENSE of a TRAINING COLLEGE for SCIENCE TEACHERS.

Prepared at the request of the Royal Commission on Scientific Instruction and the Advancement of Science.

For instruction only, exclusive of maintenance of Students and Scholarships.

MATHEMATICS, pure and applied.

1 Professor	800
1 Assistant for pure mathematics	300
1 Assistant for applied mathematics	300
1 Assistant, especially for geometry, theoretical and practical	300
In case of there being many students tutors would also be required.	
Lecture expenses	50

26060.

PHYSICS.		£
1 Professor	-	800
1 Demonstrator	-	300
Laboratory, including staff, lecture outfit, experiments and apparatus, and current expenses	-	400

CHEMISTRY.		£
1 Professor	-	800
2 Demonstrators	-	600
Laboratory, including staff, &c.	-	650

MECHANICS, MECHANISM, and MACHINERY.		£
1 Professor	-	800
1 Assistant, specially for machine construction and drawing	-	300
1 Assistant, specially for building construction and drawing	-	300
Lecture expenses, models, &c.	-	150

PHYSICAL GEOGRAPHY and GEOLOGY.		£
1 Professor	-	800
1 Demonstrator	-	300
Lecture expenses	-	100

It is doubtful whether the whole time of the professor and demonstrator would be required in this division, at all events for some years. If it were not these amounts would be reduced.

BIOLOGY.		£
1 Professor	-	800
1 Demonstrator for physiology	-	300
1 Demonstrator for zoology	-	300
1 Demonstrator for botany	-	300
Laboratory, including staff, &c.	-	400

MINING and METALLURGY.

The instruction in these subjects to continue to be given at the Royal School of Mines.

MINERALOGY.

Also at the Royal School of Mines, when a full course may be required, some general instruction being given by the professor of chemistry, and in crystallography by the mathematical assistant for geometry, when desired, in the training college.

NAVIGATION and NAUTICAL ASTRONOMY.

Special courses by some of the mathematical assistants	£ 100
Dean of faculty	100
Attendants, heating, lighting, cleaning, advertising, prizes, and incidents	2,000
	12,350
Deduct saving in existing institutions, about	4,000
Total	£8,350

N.B.—The government share of fees from private students, the total amount of which cannot very well be estimated, would make a further reduction in this amount.

REMARKS on the foregoing ESTIMATE.

1. This scheme of a science college and the estimate is based on the assumption that the college is to be primarily, if not purely, a training college for science teachers, and for the instruction of government officers. Nothing should interfere with the first object of the college, which is to train teachers for science schools, and to give such courses of instruction to persons sent by government departments



*H. Cole, Esq.,* as may be required. But so long as this object is fulfilled, and when there may be room, the public should be admitted to the lectures and the laboratories on the payment of remunerative fees.

*C.B., and*  
*Capt. J. F. D.* 2. It is considered that the professors should be able to look forward to making from 1,000*l.* to 1,200*l.* a year by means of the state payments and the fees of private students.

*Donnelly, R.E.*

17 Feb. 1871.

3. The 800*l.* a year put down in the estimate is to be taken as a guarantee that the professor shall receive that amount at least from all sources if his whole time be taken up in the government service. It would be advisable that this sum should be translated, for purposes of administration, into government students' fees. For instance, it might be taken that for each (say 20*l.*) of the guarantee the professor should be bound to teach one pupil sent by government. For 800*l.* he would then be bound to teach 40 students. If 40 state students were not sent, so that the whole guarantee were not absorbed, and at the same time the addition of the private students' fees caused the total sum to exceed the guaranteed amount, then the difference up to the guaranteed amount should be made up half by the government and half out of the private fees of the professor. Thus, supposing at any time it were not thought necessary to have more than, say 35 students in training, 700*l.* only of the guarantee would be absorbed. If the professor were at the same time receiving private fees, then the whole difference, 100*l.*, should not be paid by the government, but should be made up half by government payments and half by private fees, so long, that is, as not more than half the professor's share of fees was taken. If, in the case given, the professor's share of private students' fees came to 100*l.* he would receive 850*l.* altogether, and the government would pay only 750*l.*

4. On the other hand, if the government desired to send more than 40 pupils the professor should be bound to take them at half private students' fees. It must be understood that this does not affect laboratory fees, so far as outlay on the part of the professor is involved.

5. By taking the professor's whole time is meant not that every hour of every day is engaged, but that he is placed on the same footing as the ordinary civil servants of the crown; that is to say, that the government, with the usual allowance of holidays, has the right to six or seven hours a day of the professor's time, and to a reasonable amount of work, either in teaching, reporting, or making experiments, &c., and that the professor may not without special sanction undertake other duties.

6. The estimate has been framed on the supposition that the whole time of all the professors will be engaged. This, at all events at first, will probably not be necessary. For instance, the professor of physical geography and geology, having no laboratory to attend to, will probably only be required to give a definite course of lectures with excursions and field demonstrations, after which he would be free to take other engagements. In this case a regular payment for lectures would have to be arranged.

7. The demonstrators and assistants should be looked upon as being to a certain extent in training. Their salaries should not be fixed on a scale to induce them to remain permanently. At the same time they should be liberal enough to make it reasonably certain that they will remain for five years at least. They, as well as the professors, should participate in the fees, and thus have a direct interest in the success of the college.

8. The course of instruction will have to be carefully considered and arranged. The course laid down for the college of science in Ireland does not meet the conditions of this, which is to be primarily a training college. It will probably be necessary to lay down some general course of study—or the alternative of passing examinations in an elementary general course—for all who enter, and then to leave it very much to the student in training to select what branches of science he wishes to be trained to teach. These will depend on his own aptitude and the town or school in which he is going to teach.

9. The course in the same way may vary from one to three years. Supposing there were 100 students in the college at 50*l.* a year maintenance allowance, the cost would be 5,000*l.* per annum, in addition to the estimate given.

10. The executive staff will depend so much on circumstances and the locality of the college that it is unnecessary to consider it here. As a consultative body the professors should form a council and elect annually a dean, or perhaps it might be better that the office of dean should be taken in rotation by the professors.

11. Against the cost of the training college may be put a saving of about 4,000*l.* which will be made in the expenditure on account of the Royal School of Mines, the Royal College of Chemistry, and the Royal School of Naval Architecture and Marine Engineering. There are also

large sums of money spent annually by government for instruction at Woolwich and Chatham, which it is suggested might be saved, besides such items as 800*l.* a year for the laboratory for the Purification of Rivers Commission.

(Signed) J. F. D. DONNELLY, Capt. R.I.  
Official Inspector.

I have carefully considered this estimate and I entirely concur in it.

(Signed) HENRY COLE, Secretary.

Science and Art Department,  
31st December 1870.

5954. Probably you would desire to give the Commission some statement of the grounds on which you consider a training institution for science teachers to be desirable, and for that purpose I would ask you whether you have any statement to make as to what your own conception is of the efficiency of the existing arrangements for teaching science in the country?—Considering the very slow growth of the public demand for science, and the apathy of the public, which is only now being comparatively removed, I do not think that any very different system to that which has been followed could have been carried out. I think that the time has come when, in order to make the State endeavours for promoting science more efficient, a higher and better class of men than at present are generally to be found should be produced. I am of opinion that if the theory had been carried out, as it was started in 1852, to initiate an extensive training school for teachers, in the then state of public opinion you might have incurred the expense, and the teachers would have starved. I feel perfectly certain that at that time there was no demand whatever to any extent justifying the creation of a training school for science, and that opinion is based upon careful watching of the art system. At this very time if the art masters had to depend wholly upon the fees which the artisan part of the public are willing to pay, together with the payments on results which the state gives, they would all be starved. They have to depend in the main for their living upon the middle classes, and by a sort of mixed system as far as may be possible of answering the wants of all classes. I think the time has come, and will come more impressively than now, when a superior class of science teachers will be required. I think therefore that the time has come when the recommendation made in 1852, by Lord Aberdeen's government, should be carried out.

5955. Can you describe in what schools and institutions you would expect that the teachers trained in the proposed normal school would find employment?—There are institutions and schools already which want masters of a higher and more advanced character than those who are picked up under the present system; but I think it is quite clear that in the progress of the education of this country it will be necessary in all populous places having a given number of people to have different grades of schools; and instead of the system which has grown up of every independent chapel having a little infant school or a little mixed school for children of all ages, from anything up to 12 or 13, with the master to go over the whole range of instruction, from that of the little infant up to the youth of 12 or 13, I think I foresee that schools will be organized—infant schools to do infant's work; a lower grade of elementary schools to do elementary work; a second grade of schools; and finally, at least one school to take up the instruction where youths would stay till they were 13, 14, or 15. I think there are symptoms that instead of the state aid being given simply to people who are called artisans, which is very difficult to define, it will be given rather for the things themselves, and that all classes will insist upon participating in the advantages. Therefore I think the time has come, and in the course of a year will be still more ripe, for the employment of teachers who are able to teach specialties and teach them efficiently.

5956. In considerable communities you would expect that a superior elementary school, and probably a middle-class school, would find employment for science



teachers?—Certainly; I have no doubt at all upon that subject.

5957. In more scattered and smaller communities have you a conception that a master of high qualifications might give instruction in a group of schools in a district?—I have no doubt that he might.

5958. Likewise do you contemplate that certain of the second grade or first grade of endowed schools would require the aid of scientific instructors?—That I have no doubt about also.

5959. Have you formed any conception of the proportion in which you would think it necessary that the stipends of those masters should be provided by the state?—That must be found out rather by experience than by any theory. As a general principle I should say that the less they depend upon the State the better, and the more they depend upon the results of their teaching the better; but I think that whatever the proportions may be, it is quite essential to make the living of all teachers, professors of the highest grade included, greatly dependent upon the success of their teaching.

5960. Up to this time the great preponderance of the remuneration of science teachers has come from the State, has it not?—Yes, I should say so. It has not been a great amount. In fact, the schools where a science teacher has made what would be considered a decent living for a fourth-rate tradesman are only two, or three, perhaps. There is a case which I have in my eye now of an efficient master looking after a great number of schools, taking a good deal of risk upon himself, where his committees are moonshine more or less, and he has a hard struggle to make 200*l.* a year with a great deal of slavery. The artizans wishing to learn science are only just beginning to bear paying fees.

5961. Of that 200*l.* a year do you think that as much as a tenth part is derived from the artizans?—I think in the case of the science teaching the greater part is derived from the artizans, and from the middle class to a very small extent.

5962. I mean in proportion to the money obtained by payment for results from the Department?—The proportion obtained from any source whatever excepting the Government is rather less than a quarter.

5963. Your desire is to see what you have regarded as an experimental but useful system superseded by the employment of teachers thoroughly trained, not merely in science but in the art of communicating science?—I cannot answer that question by the single word "yes." I think that the present system has been experimental and useful. I think it will not be superseded by the creation of a better class of teachers. Although I think that there is a great want of the better class of teachers, I believe it will be a very long time before you can lay down a drastic rule, indeed that no one but a highly qualified man shall teach science.

5964. You desire that thoroughly trained and highly instructed teachers should in the end be mainly employed in the instruction in science rather than the class that now are so engaged?—As a very important supplement to the present system, with such improvements in the present system as no doubt will prove to be necessary.

5965. Would you desire that to the extent to which it now exists, the instruction in science should be conducted in the evening by masters employed during the day in elementary schools?—At present the best is done that can be done under the circumstances; but if we get to a proper division of labour, then I think that you will have a master who may teach an elementary school of science in the daytime, and still do a little science work in the evening. I see nothing to prevent a teacher of geometrical drawing teaching, if you like, in a grammar school, some geometrical drawing instead of Greek during the day, and in the evening attending to a mechanics' institute and teaching geometrical drawing there, without being greatly overworked.

5966. My question had reference to the ordinary

employment of an elementary schoolmaster, who is engaged during five hours in the day in instructing rude children, and an hour and a half besides that in teaching his pupil teachers, and who ought likewise to prepare himself during the evening for the instruction of his classes?—That is the present defectively organised system which I hope to see reformed. If I am asked whether I would drastically forbid that man to do anything for science in the evening at the present time, I should say, No, I would not, but I should hope to see the work done a great deal better by-and-by.

5967. Glancing at the estimate of the annual expense of a training college for science teachers, I do not perceive that there is included in it any means for the practice of teaching by the students; is it intended that they should all pass through the function of demonstrator, or in what other way is it intended that they should acquire method in instruction in science?—I find some difficulty in answering that question very precisely. If it means that you are to collect a number of youths for the professor in chemistry with his students in training to experiment upon, it is a point which I have not considered. I know that that is thought necessary in the case of different normal training schools; for example, I am not prepared to say whether it would be necessary, but I think that the professor of chemistry would be neglecting his duty if he did not, after having gone through his course of instruction to his teachers in training, take measures for finding out whether they were or were not likely to impart that instruction to others in an efficient and competent way. It may be necessary that they should have a vile body to practise upon, but I am not quite prepared to say whether it is so or not.

5968. You are probably well aware that the experience of endowed and other schools which are supplied with masters from the Universities, is that their position in the tripos is no measure whatever of their capacity to teach?—Certainly, I am aware of that.

5969. Consequently, if you are preparing a class of teachers, would it not be expedient that before they are sent forth to teach, whatever capacity they have for teaching should be by some method developed?—The capacity for teaching is, in my opinion, like the gift of making poems. You do not find one in a thousand who really has a great aptitude for being an efficient teacher. It is also like the capacity for preaching a good sermon. You do not find one clergyman in a thousand who can preach anything that you are very much enamoured of hearing; but I can conceive that it would be quite possible before the State allows a person to come up to be trained as a teacher, that security should have been taken that that man has a reasonable amount of capacity for imparting instruction. It might be quite possible to say that a man who desired to be a science teacher, and who had given some proofs of aptitude for acquiring a knowledge of science, should have passed a certain amount of probation as a teacher in an inferior subject; but I quite agree with what is implied in the question, that the mere setting a man to listen to lectures and examining him, and finding that he can repeat what he has been told, is no proof that he will be a good teacher, and that some measures (what I am not prepared at present to say) are absolutely necessary to make him prove that he will turn to good public account that which the state has paid him for acquiring.

5970. You are convinced that the experience of the best teachers in the method of communicating knowledge may scientifically be in some degree communicated to persons who have less capacity than themselves?—Yes, certainly.

5971. And that it is worth while not merely to convey the scientific rules, but in some degree to train an inferior capacity in the practice of those rules?—Entirely. I think that there is an art in teaching which is capable of demonstration.

5972. And that that art of teaching is as applicable to science as it is to literature?—Quite as much so.

5973. Having regard to the continuance to a certain degree for a period which must necessarily be indefinite

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17 Feb. 1871.



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17 Feb. 1871.

of the present means of conveying elementary scientific instruction in the country, and to there being superinduced upon it such improved instruction as you would desire, have you any suggestions which you could make to the Commission as to the inspection of schools so conducted?—I have not arrived at any very fixed conclusions upon which the inspection should be based. Before I could do so I should have to find out what inspection means, and what it was to do. I think it may be very desirable in the future to have some work done by inspectors which cannot be accomplished by paper examinations. At the present time, in the last two years especially, Captain Donnelly has matured a system of inspection by officers of Royal Engineers, which secures in the first instance that the committees, which are voluntary bodies, do their work fairly well, and which to a great extent prevents fraud in the examinations, and then the professors deal with the examination papers. I think it very likely indeed that in the progress of educational organization it may be desirable to have competent scientific men to visit the schools and to see to the instruction imparted in them more than is done at the present time. But that is rather a matter to find out than to lay down rules for at the present time, I think.

5974. Supposing that, or something of that kind, to be found desirable, might not there be an avoidance of waste of power if the inspection of the elementary, the superior elementary, and possibly the middle-class schools, were co-ordinated and consolidated so that by a graduated inspection they might be all embraced?—By “consolidated” I presume you mean under one authority upon a uniform plan.

5975. Under the supreme authority of the Education Department?—Yes, I think so.

5976. Not entering into the detail of such a system, you conceive that it is desirable in the long run to develop something of that kind?—I think it is absolutely necessary; *quâ* science, I have no doubt that it would be very useful; *quâ* endowed schools, which would be mixed up I apprehend in some way or another with scientific teaching, and their funds turned to better account even for primary education, I think that unless they be closely looked after, they will not do much better than they have done for the last 100 years.

5977. Perceiving that the idea in this estimate is that the expense of a training college will be to a very large extent indeed borne by the State, and that, probably, the amount of the contribution of the students attending will bear a very limited proportion to that expenditure, have you thought of any kind of guarantee for the number of years’ service which you could properly obtain from the students who have received the benefit of that training?—The best guarantee, perhaps, is the demand of the public for their services. If I were to ask the chairman, from his great experience of primary education, whether he ever exacted a guarantee from the female pupil teachers that they should not marry, but should absolutely remain teachers, I should expect the reply that he never did exact it, and that if the attempt were made it would be difficult to enforce such a requirement. In the same way, if, after having trained a man to teach as a teacher of chemistry, he should desert the occupation of a mere teacher, and should become a most eminent professor, devoting his ability to chemistry in general, I am not altogether prepared to say that that would involve an abuse of public money, although the first object of training him was to make him a teacher. I do not see daylight in exacting very precise guarantees, although I think that something might be done in that direction.

5978. Supposing that a man, having received the very superior instruction which is proposed to be given in this college for training teachers, we will say in chemistry, afterwards found (as has been the case within my own experience) that he would be very valuable at works in which his knowledge could be applied, and that instead of receiving 250*l.* a year as a science teacher, he could probably receive 500*l.* a year, or more, as a partner in those works, would it not be reasonable

that he should at least pay for the cost of his training?—That might seem to be reasonable, but whether it would be practicable I am not prepared to say. I am prepared to say this, that I do not think it is a bad State adventure. It is a good thing for the country that you should have evolved a man of that kind so to improve industry, which means the employment of its people, which means their cultivation in a moderate degree in science, and, though not directly being a teacher, he is at the same time doing that which really makes work for the teacher.

5979. Would not some guarantee of that kind at least have this effect, that it would serve as an indication of a moral obligation, and might deter persons from coming who really had no desire to become teachers?—You may take what security you please, but in the long run I think it would be best to leave a man to do the best he could for himself. For instance, we have trained men to become teachers of drawing and painting, for the particular purpose of being masters of schools of art; and some few of them, a very small number, have emerged from that horizon, and have become more or less distinguished as painters of pictures in general. If you ask me whether the operation of that is disadvantageous, and whether any good would have arisen from a man’s finding security that he should slave away as a teacher in a school, I should say I do not think that there would be any at all. I think the whole influence of a man emerging from the ranks is good; it induces a better class of men to come up to be teachers; and if they can do something better than teaching, I think it is a good thing on the whole that they should do so.

5980. If after the establishment of this training college you found that the proportion of men who deserted the function of teaching and entered into the general application of science to industry in the country was very great, would you not think that that would at once form a grave reason for the reconsideration of the whole scheme?—I should deal with those circumstances when they had arisen. Captain Donnelly reminds me that if you exact a guarantee and make it a sort of contract, you are bound to find the man employment. If you find that the teachers are not wanted after a certain time, and that the public do not employ them, then I think it will be high time to consider whether you will go on with your training school.

5981. The condition of the question was not what Captain Donnelly has suggested, but that having fair means of employment they should give up 250*l.* a year for the purpose of securing a much larger rate of remuneration in mercantile employment?—If any means can be adopted for their paying back the money to the state, in my opinion there are no strong objections to it, but that you can adopt any effective means to compel a man not to follow his own interests I do not believe.

5982. Having a specific object in view, the tendency of my question is, what is the nature of the guarantee which the state would have that that object would be attained?—Much would depend in my opinion upon the mode by which students were admitted to the college. I can conceive a system something of this kind, that the admission to this college should be coupled with a previous demonstration of efficiency as an elementary teacher; but a man having shown that he is a good elementary teacher, and that he is willing to make the sacrifices of coming up to London, and of living upon 50*l.* a year for two or three years to be trained in a science for which he has shown an aptitude, is of itself a good guarantee in my opinion. I should not expect a large number of that class of people to emerge out of the station of science teachers; if there were five per cent. I should rather rejoice than otherwise.

5983. But, on the other hand, supposing that from some chemical works, or from some large establishment for dyeing, or from some considerable calico printing works, there came up a man of considerable talent to improve his knowledge of chemistry in this training college, would you enable him to acquire that knowledge on the same terms as you would a man who was



willing to devote a considerable portion of his life to scientific teaching?—Certainly not. I would take every practicable security to keep a man to his engagements, and a man who came up from a manufacturing works should pay the full fee, and should be no charge whatever upon the State.

5984. (*Dr. Sharpey.*) With regard to the buildings that you spoke of, for which there is provision made already at the expense of 66,000*l.* (I mean when they are finished), and which will require about 45,000*l.* more, do you not think that the Jermyn Street establishment might be used for carrying out this scheme to a considerable extent; I mean the theatre in Jermyn Street and the laboratories there?—I think not. I think that if it be desired to maintain the Jermyn Street establishment (which has very insufficient accommodation for its purposes) as a teaching place at all, it would be well to keep it to the specialties of mineralogy, mining, and metallurgy only, as a part of the whole system. I think that great inconveniences would result from sending students from the one place of instruction to the other, excepting for the period of a year or two, during which they were going through a special course.

5985. But do you not think that it would be proper and economical, looking to the public interest, to utilize as far as possible those establishments which the government have been induced to plant in London for science; for example, take the case of geology or mineralogy, which is contemplated in the scheme which you have put in of a training college, could not all that be obtained at the Jermyn Street institution, which seems to be adapted for it?—Theoretically it might seem well that you should get the science wherever you can get it, but I think if you contemplate training teachers and keeping them under rules, and seeing that they attend to particular work, they paying no fees, there would be the gravest disadvantage in sending them about to different parts of London for instruction in that work. It is far better upon the face of it to bring the professor to the students than to send 50 students to find the professor. As respects Jermyn Street, the building at Jermyn Street is not nearly spacious enough for the proper administration of the Geological Survey; and although I have nothing much to say against keeping (in fact as is pointed out in this paper) mineralogy, mining, and metallurgy at the School of Mines, if it be thought economical to do so, I think that Jermyn Street will, from a geological point of view only, as a geological museum, and from the survey point of view as a collection of mining statistics, have to be reorganised before long. Indeed, you are probably aware that one or two not very commodious private houses adjoining the Jermyn Street museum have been added to the premises. There has been a demand before the Department, not long since, to take in another house, and at this present time I think there is a demand from Sir Roderick Murchison before the Office of Works to find him additional accommodation. I am of opinion, therefore, that the best possible thing to be done with Jermyn Street is to make it as efficient as may be for the purposes of the Geological Survey, but no amount of patching up there will serve the purposes of the teachers who are to be brought up to town to be instructed.

5986. This new building which is at present in progress at South Kensington is intended, if I understand rightly, for a college of chemistry, and a school of naval architecture and marine engineering, is it not?—Primarily for a School of Naval Architecture and Marine Engineering, and next for accommodation for the teaching of chemistry, whether superseding the College of Chemistry or not it is not for me to say; but those buildings now being erected at South Kensington will supply good accommodation for the School of Naval Architecture and all that it teaches, and good accommodation at the top for the teaching of chemistry, and, in addition, some space for exhibiting educational apparatus.

5987. With regard to the other branches requiring the additional 45,000*l.*, what would the additional

buildings be devoted to?—They would be devoted to all the requirements for teaching those various sciences.

5988. Take, for example, mathematics; it would not require a large space, would it, for teaching mathematics?—Not a large space, but we should require some, a class room certainly.

5989. But as a rule the same room might be used for other purposes at other times, might it not?—I presume it might.

5990. I mean that you do not require a special class room, because there is no special arrangement for teaching mathematics?—You must have space for the students.

5991. But not to work at benches as they do in the chemical laboratories?—If you are to bring up 50 or 100 young men from the country you must have space to put them about in different rooms to do their work. The present arrangements have not contemplated what is contemplated in this paper.

5992. Are there no theatres now at South Kensington that could be available for that purpose?—None at all.

5993. How many teachers would you expect to come up to be trained?—That is a question rather for the Chancellor of the Exchequer than for me.

5994. In making out a scheme of course that must have entered into your calculation?—This estimate calculated upon 100.

5995. You would require a physical laboratory and apparatus, I presume, for teaching physics?—I presume so.

5996. I do not know how they are off for a laboratory at Jermyn Street at present, but they have got of course apparatus and a theatre which would accommodate 600 or 700 persons?—Yes, it would accommodate 600. Of course if the change were made the apparatus that they have there would come to Kensington.

5997. That is part of the saving, is it, that you would look to?—Certainly; but I do not think that they are abundantly supplied with apparatus at Jermyn Street.

5998. But would you transfer the professors who now give instruction in physics at Jermyn Street to the new establishment?—Certainly.

5999. Would you contemplate a geological collection, or would you utilise the British Museum and collections that will be in your neighbourhood?—Exhibition in a museum is one thing, and handling specimens is another. I suppose there would have to be a small typical teaching collection; perhaps a very small one.

6000. Then in reference to biology, I presume that instruction would be chiefly given in lectures, on prepared specimens, or dissections of animals?—It was contemplated to have demonstrators for physiology, zoology, and botany, each of which, more or less, a special subject.

6001. Not having gone into figures in the way that has been done by Captain Donnelly, who is much more able to judge, it seems to me that 100,000*l.* is a very large sum to expend upon an establishment of this kind?—Do you think that this, being a national affair, and to be done, I assume, properly, should be done upon a more starved scale than that of Owens College for its purposes, or of Glasgow University is now for its purposes, in both of which places an expenditure a good deal beyond 100,000*l.* is contemplated, if not actually incurred?

6002. I mean that the existing establishments should be used as far as practicable?—I am quite of that opinion.

6003. Would you at all contemplate any alternative means of training? Suppose, for example, that in that establishment which you mentioned just now, Owens College, they could undertake to train the teachers who live in that neighbourhood, where there are so many manufacturers and so many scholars in fact requiring to be taught science, do you think that that could be at all contemplated?—I think that the training of teachers is a kind of specialty of its own, implying a discipline and watchfulness for which the

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17 Feb. 1871.



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freer and easier system of a public school or a university hardly provides. I am unable to say if it would be worth the while of Owens College to create a branch for the training of persons as teachers; but, even supposing that the work could be done, I think the State could hardly enter into engagements and obligations towards the teachers without bringing them up to some place for which the State itself were responsible. That seems to me to be implied in the fact of certificating a man as a teacher—not for the mere knowledge of a subject. I think that experience in elementary education has shown the positive necessity for particular instruction in the art of teaching. You have now, perhaps, 40 training colleges; still they have lasted for a long time and have done their work well, and I think it is a moderate demand to say that if you wish to train science teachers you must have one place particularly adapted for that purpose.

6004. Without proposing anything of the kind, I would like to ask your opinion upon this point. Supposing there were a normal school in which science was taught upon the best methods, would it at all be a feasible plan to pass teachers through an examination after they had brought evidence of their having really acquired in a proper establishment a knowledge of the branches they were to teach, and then to employ them for a time in this normal school in witnessing and practising the best mode of teaching; do you think that would be at all feasible as an alternative plan to the establishment of this training college?—I understand your question to be whether it would be desirable to exact from young men wishing to be teachers that they should have previously passed through some college or place of instruction before they come up as a final operation to this training school.

6005. I do not refer to a training school where they would learn chemistry, for example, or mathematics. I am presuming that they have studied chemistry to some purpose, and that they bring evidence that they have really gone through a *bonâ fide* course of chemical study, both theoretical and practical, that then they come to London and are subjected to an examination to see how far that instruction has been efficient, or how much they have benefited by it, and having shown that, could they not be introduced into a school where science was taught after the best methods, and learn in that way the duty and the art of teaching it, instead of creating this great establishment by a large application of public money?—There are two or three points connected with your question. The class of people who would come up, or who I expect would come up, to be trained as teachers will probably be persons without means, whose friends could not afford to assist them much, and towards the cost of whose maintenance the State must pay at least 1*l.* per week. That I conceive is almost necessary if you wish to take an elementary teacher away from his school, where he is getting his 120*l.* or 130*l.* a year, and say to him, You must go through Owens College and learn a certain amount of chemistry before you can be admitted here; I do not quite see at whose risk that is to be. I think that it might be very desirable as far as it could be tried, and it ought to be tried to induce the people to come up with as much qualification as possible, which implies their getting it at Owens College or a similar place; but if you were systematically to set about creating a superior class of teachers, I am afraid you must find the capital to maintain them whilst they are going through this operation; and I think it will be found the cheapest and most effective plan to bring them up to one place at once, always remembering that the more knowledge a person can provide for himself, and can bring with him, the better.

6006. You see that the maintenance of those persons is an exceedingly important element in the whole case, and you are quite of opinion that that would be necessary?—Yes. Let us try and realise the field from which those teachers are to come. A man getting say 80*l.* or 90*l.* a year by teaching in an elementary school, but who has some instinct for science, desires, instead

of teaching the three Rs, to come up and qualify himself to teach two or three sciences. How is that to be brought about? You want him, and the man wants to come. He has no money, and you on behalf of the public want him. I think you must find the means for inducing him to come, with such guarantees as the chairman has pointed out.

6007. The general answer would be that where there is a demand for a man's service you should look to the payment for it as the payment for his education, just as when a young medical man is educated in a medical school, there is a certain outlay and certain maintenance required, but he expects by-and-by to get a return for it; is the question which we are now considering something so very different?—I think it is the same with regard to education throughout the country. You would not get people to go to the Universities if you did not bribe them with your scholarships of 200*l.* or 300*l.* a year, even when they are comparatively a rich and not a poor class, such as those teachers would be; but the laws of political economy do not seem to me to apply to education. If the public want those teachers, they must pay for the creation of them accordingly. The public fancy that they want them, and there is a growing demand for them.

6008. But you see that in this case the public are to pay through the State, whereas in common cases the public pay by giving employment?—Yes; but I think that the public want physic for their minds in the same way as they want it for their bodies, and are not willing to pay for it.

6009. I think you gave some explanations to the chairman about the conditions of admission. What would be the claims that any individual would have to establish to this great advantage of being maintained and receiving instruction at this school for nothing?—Of course you would have to lay down your conditions. You would have, from the teaching point of view, to see that he has shown that he can be a teacher, and that he is not lame nor blind, and that he is in good health, and that he has some aptitude, perhaps, for the training that he desires to have. I ought to say, with regard to a previous question of yours, that when the Art schools were first originated, the practice was to bring students up from all parts of the country by such competition as was desirable, and to maintain them, and to give them different weekly allowances; but our practice now is not to pay a weekly allowance until the student has obtained a certain grade of advancement which he gets in the country, so that it might be quite possible, after the scheme of science training has been generated and set going, to exact a much higher standard for admission than you could at the beginning.

6010. Looking to the new School of Chemistry, and the modified condition of the College of Chemistry henceforth, supposing your plan carried out, and to the opportunity of making chemical examinations, analyses, and so on, for the public service, and (as was pointed out in Captain Donnelly's scheme, and by Dr. Frankland in his evidence the other day) to the saving to the public by an establishment of that sort with sufficient accommodation for the purpose, do you think it is really advisable that there should be places appropriated for what are called beginners, and that those should necessarily be taught in a State establishment?—My impression is, that you should not begin quite at the beginning in this place, but that there should be some qualification required. For instance, you certainly would not begin to teach the simple rules of arithmetic preparatory to mathematics.

6011. Then again with regard to the question which the chairman put about the security that a teacher would continue as a teacher, I think that was chiefly suggested by the fact that Dr. Frankland said that he would contemplate giving nine months' instruction in practical chemistry, and to occupy thereby the larger part of the pupil's time while he was in London, which nine months' training in practical chemistry would



almost fit a man to enter upon some chemical manufacture and lead him to offer himself for employment in that way, in which he would make a great deal more than the 200*l.* or the 250*l.* which he would get by drudging as a teacher; in fact it is almost inevitable that that should happen?—I think that the demand on the part of manufacturers for such persons will not be anything like so great as the demand for schools all over the country. No doubt in the case of a man who has become very apt in all the practice of chemistry, so long as manufacturers are willing to give 1,500*l.* a year, or a great deal more than he can get by teaching you would be exposed to that risk, but I do not myself see a disadvantage in that.

6012. (*Sir J. Lubbock.*) Did I rightly understand you to say just now that the laws of political economy did not apply to education?—Such is my faith.

6013. In what sense do you use that expression?—I think that the public get most things by wanting them and somebody else supplying them, but I do not think that people want education very much. I have yet to learn that they desire it very much, and therefore you have rather to force it down their throats.

6014. Then you mean to say that there is not likely to be a supply without a demand?—I said in the early part of my examination that I thought that if you had created 100 science teachers 20 years ago they would have had a fair chance of starving, and even now the thing would have to be done very cautiously, that is to say, not to create too many, because it has yet to be found out whether they will be used, whether this superior animal which has already cropped up by the present harum-scarum process is going to be turned to any definitely good account. It is an experiment.

6015. Surely that is entirely in accordance with the laws of political economy; if you create an article for which there is no demand that article will not be sold?—Education is not self-supporting, it is not like bread and cheese. The provision of education is not, excepting under very lucky circumstances, a thing that yields great profits. It is not regulated, in my opinion, by the rules which regulate the production of food, clothes, and the like. I would refer you to where the idea is well worked out, in a way that convinces me, at least, in John Stuart Mill's Political Economy—he excepts it from all the ordinary rules of political economy. In the case of education it seems to me justifiable for the State to interfere in a broad point of view, whereas it would not be at all desirable for the State to interfere with the production of breeches and coats.

6016. There may be a state of things, may there not, in which, according to the laws of political economy, it may be desirable for the State to interfere?—It would be good economy for the State to let people do for themselves what they want for their bodily economy, and their clothes, their health, and so on, although even in health we are beginning to interfere a little; but in the case of education, what is called scientific education, and art education, both comparatively new at the present time, and not based upon the old traditions of monasteries and early teaching, I think it is the function of the State to avoid arriving at the conclusion that if education in science and art is good, people will therefore want it, and will take means to obtain it. I do not think that people would get it at all unless the State interfered.

6017. Then it is to the mistaken application of the laws rather than to the laws themselves that you object?—I will not demur to its being put in that manner.

6018. In this particular case of the training college which you are proposing to establish, I take it that that is necessary, in your opinion, because the science teachers do not as yet get a sufficiently high remuneration for their services to make it worth their while to go through the training?—That is so; there is no sufficient demand for them.

6019. Therefore if you are not prepared to pay the necessary price you must manufacture for yourself?—

Yes; owing to the ignorance of the public they are not up to the point of adequate payment, and the article is not forthcoming, and therefore it is my opinion that it is the function of the state to interfere and to try to get its people instructed in science.

6020. (*Mr. Samuelson.*) You spoke just now of the system pursued in reference to the selection of the pupils of the art schools. Can you state briefly under what conditions art pupils were first admitted to your art schools, and what the conditions are now?—At the beginning, when the art training school was established, a student had to prove that he possessed a certain moderate amount of competence in drawing, and he had to enter into something like the engagement that the chairman has pointed to, that if we paid him so much a week he would keep to the times of the school, and that he would stick to the business, and that he would hereafter be a teacher. That went on for three or four years, being cautiously tried, until a certain number of teachers were created, and gradually the demand for such teachers increased. When the art system was first established, there were only 18 or 19 art schools, mastered by old worn-out drawing masters who knew nothing about teaching, and could not get bread and cheese excepting by professing to teach those schools, and who gradually were superseded by teachers especially trained to teach drawing and painting. At the present time the conditions are a great deal more rigid. Nobody gets a payment now unless he have taken a first-grade certificate, which implies a good deal; in the earlier period of the system this certificate was not required to be taken for at least a year and a half by the students in our schools. Now we require that the student shall bring up his certificate; he may get it by working at Kensington, getting no support, or he may get it down in the country at his own local school, and coming up to the national examination and obtaining and producing his certificate. And I daresay that something analogous could be devised in the case of science.

6021. You do not think it would be necessary to be so lenient at the present day with regard to the entrance of science teachers as it was at the very beginning of the institution of your art school?—I should say not quite so necessary; but we have yet to find out how to do the business as we want it done.

6022. At the present moment there are a certain number of science teachers who have made some little progress, and the circumstances are not quite so unfavourable to science as they were to art at that time?—Certainly not; they are much more favourable.

6023. So that there would be nothing to prevent your imposing tolerably rigid conditions at present for entrance?—They might be tolerably rigid.

6024. In the main your pupils would be men or youths, would they not, who had already been partly trained as elementary teachers?—I have pointed to that as a probability.

6025. You would draw, would you not, from that class and from the present class of science teachers?—Yes. Some of the present class of science teachers may be clerks to chemists and druggists, they may not have been elementary teachers, but they may have shown themselves apt for the business of teaching; therefore I should not lay down the positive rule that a man must have been an elementary teacher in a school.

6026. In addition to elementary science teachers, you would admit, would you not, persons who were qualifying themselves to become elementary teachers?—Yes, under various conditions. I should not be disposed to pay a very high bounty upon those who did not come with a pretty good demonstration of aptitude. You might say to a man who gave promise of being a teacher, and who evinced some aptitude, "You shall come in without payment of fees." You might say to another man, "Yours is a more pronounced case, and you shall get 10*s.* a week;" and you might say to a third man, "You are a very eligible man indeed, and you shall have 20*s.* a week;" so that you might go

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17 Feb. 1871.



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 through various grades, sifting and economising your expenditure, and getting the right people. You might increase the allowance to those who turned out well, and just keep above starvation point those who wish to be teachers.

17 Feb. 1871.

6027. With reference to young men who had passed creditably through the elementary training college, would you not admit them on favourable conditions?—I should consider that worth something more than nothing, but I should not value so highly a man who might come from St. Mark's Training School without having proved his competence to manage a school, and to teach as much as would be necessary, were he to have the actual charge of a school, as I should value a man who had actually had a school under his charge, and who at the same time showed a disposition to become a special science teacher.

6028. (*Chairman.*) You are aware, with reference to the last question, that seven ninths of the students of training colleges have gone through the apprenticeship of five years in the elementary school, and are actually likewise trained in the methods of teaching during the two years that they are in attendance upon the training college. Consequently, as far as method is concerned, they would come to your training college with a very considerable acquaintance with the art of teaching?—Yes.

6029. But if they superadded to that some knowledge of science obtained in the training college or elsewhere, that would in your view be a considerable qualification?—Certainly a high qualification.

6030. Supposing that elementary teachers had a more ripe acquaintance with science than they at present have, and that there were attached to certain elementary schools a superior department in which science could be taught to boys of a riper age, might not a pupil teacher at the end of his apprenticeship be allowed with advantage to select whether he would go to the ordinary training college, or whether he would come up to the science training college, and would he not at the end of five years, being so qualified, be very eligible for admission?—Yes.

6031. You are aware, are you not, that it has been the practice in certain of the elementary scientific schools now taught in the evening in the country, to employ a class of assistant teachers who have been called by various names, local teachers or candidate teachers, and who have discharged functions similar to those of pupil teachers in the elementary day schools?—Yes.

6032. Supposing that a young man had creditably performed those functions for a year, and had shown an aptitude for teaching, and had acquired a knowledge of elementary science, I apprehend that he would likewise be a very eligible person for admission into the training college?—Yes, certainly.

6033. (*Mr. Samuelson.*) Taking those various classes of persons who might enter, would you require the same entrance examination from all, or would you let each compete in his own class?—I cannot off-hand say what would be exactly the best mode of proceeding, but I would have as fair a competition as I could devise.

6034. In fact you have not yet considered the details of the entrance with regard to teachers?—No. I can see analogies in the working of the art system that would be applicable to this, but I should hesitate to do more than make a scheme and try it for six months. I am speaking now as to the admission.

6035. You contemplate, do you not, the fusion of the present School of Mines and the College of Chemistry with this training school?—I think that that would be an advantage to the public.

6036. In the School of Mines I believe there is no entrance examination whatever?—I am not able to speak as to the details.

6037. Assuming that which is the case, that there is no entrance examination in the School of Mines and the College of Chemistry, it would almost be necessary, would it not, on account of that fusion, to retain the

elementary department in your new college?—I am not so sure of that.

6038. Do you mean that in consequence of that fusion you might see fit to alter the curriculum of the old institutions?—I would rather not pass any judgment upon the old institutions.

6039. You would not consider it to be necessary to pledge yourself to maintain the rules of those old institutions?—Certainly not.

6040. Assuming that those schools should cease to give very elementary instruction, some portion of the space, namely, that which otherwise would have to be devoted to that elementary instruction, would be saved in your new school, would it not?—I do not think we have contemplated very elementary instruction in our new school. I do not think we contemplate teaching arithmetic.

6041. My question had reference to elementary scientific instruction?—I call arithmetic part of elementary scientific instruction.

6042. To take the science of chemistry specifically, are you acquainted with the evidence which was given here on Tuesday by Dr. Frankland, in which he stated that a certain portion of the space would be required for elementary classes in chemistry?—Of course it has to be precisely defined what you mean by "elementary," and it has to be gravely talked out in the precise details. I do not think I could give you any answer that would be useful upon the subject. I do not think that a person coming up at the cost of the State should be admitted to an institution like this quite at zero in his information, but how much above that is a matter to be found out when you set about the business. By this scheme it is proposed to have 100 students; they will come up in various stages of competency certainly at the beginning, whatever you may be able to fix afterwards, and 100 students require so much space.

6043. I take it that in your opinion no portion of the space assigned to chemical laboratories in the new building could be devoted to any other purpose?—I repeat what I have already said, that I think the building that is now in construction is well laid out to accomplish the views which were entertained when it was started; but that if it were desired to establish forthwith a training school for science, you could make provisional arrangements in that building, and by other provisional arrangements that exist now, to start the school as soon as that building is ready. Therefore, from that point of view, it would not be quite correct to say that we could not make any use of the existing space for the College of Science.

6044. I am speaking merely of the laboratory space at this moment?—That laboratory was laid out for the purpose of answering the demand of the science teachers, who come as they have been accustomed to do, and are still increasingly desirous to do, and also of the College of Chemistry, with a considerable number of students coming from the public. If you say that you will not admit any outside students, and that you will keep it rigidly for the purpose of training teachers in various ways, then of course you could use a good deal of it.

6045. But assuming that the pupils of the existing Government schools are absorbed by this new school, would it be possible to carry out the school efficiently without this large additional expenditure of between 40,000*l.* or 50,000*l.*?—Not most efficiently, but tolerably so. If the Commission are of opinion that a training school should be established, if the Government are disposed to find the funds, and Parliament are disposed to vote the money, the cheapest plan would be to establish a thoroughly complete institution; but like everything else, you can do something less perfectly with less perfect preparation and appliances.

6046. In the event of the 40,000*l.* not being immediately forthcoming, I suppose you would retain the buildings or some portion of the buildings of the present School of Naval Architecture?—Some portion of it, in the event of its being contemplated to have this extension. I ought to say that I think any extension



must go upon the other side of the road. I do not think that, without impairing the arrangements of the South Kensington Museum, the building could be put upon that ground; but I apprehend that there would be no difficulty in putting it on the other side of the road, where there is plenty of space.

6047. If the question were one of choice between, on the one hand, merely utilizing this new building for chemistry and the School of Naval Architecture, and leaving the other departments at the mining school ill accommodated, as they are at present, and on the other hand going on with your present buildings, on what you call a provisional footing, which of the two would you choose?—The latter, without any doubt at all. I have no doubt that if Lord de Grey told my Department that it must do the best it could with the existing facts at Kensington, and assuming the new building to be finished, we should be able to do something that would not be discreditable; and although it would not be as perfect as if we had an additional building, it would be a good deal better than what we can do now.

6048. You would continue to conduct the training school for teachers, in addition to the other government schools now existing, with the accommodation now provided?—Yes, I would pledge myself to do that, more or less effectively.

6049. So that if the further grant of 40,000*l.* were now refused it might be left to time?—Yes.

6050. Assuming this training school to be conceded to you, it would necessarily take some time before it could be put into operation; do you in the meantime contemplate any means of increasing the efficiency of your science teachers?—It is contemplated to bring up an increased number of teachers, and to give them during a certain period of the summer more precise instruction than they have hitherto received. You probably have seen a minute which has been passed upon that subject. In fact it is intended to extend the period during which they are in training. The minute is as follows:—

Science Form, No. 430.

South Kensington, December 1870.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

At South Kensington, the 30th day of December 1870.

By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education.

1. My Lords have before them the applications from science teachers to attend the special (six weeks') courses for training in teaching at South Kensington in June, July, and August, in accordance with the circular of September 1870.

2. These applications are so numerous that it is impossible for the Department to make the selection of teachers to attend, as was originally proposed. My Lords have, therefore, decided to make the selection by competition at the next May examinations.

3. The competition for those who wish to attend the instruction in biology will be in animal physiology, zoology, vegetable anatomy and physiology, and systematic and economic botany. The candidate may take up all the four subjects, but a fair proficiency in animal physiology and in vegetable anatomy and physiology will be essential. If this proficiency is shown, the marks obtained in the other subjects will be counted. By fair proficiency is understood the amount of knowledge required to pass in the advanced stage.

4. For those who wish to attend in experimental physics the competition will be in acoustics, light and heat, and in magnetism and electricity.

5. A candidate will be required to take up the honours papers in those subjects in which he teaches, or in which he is qualified to earn payments, but in any of the other subjects of the group in which he is competing he may take the advanced or the elementary paper. The marks obtained in these subjects will count as in the competition for Royal Exhibitions. The papers of the teachers who are competing will be specially and separately looked over by the professional examiners—the examination being competitive only—and the teachers who answer best, probably to the number of about 45 in each group, will be allowed to come to London for the six weeks' course of training. They will receive their travelling expenses, namely, second-class railway fare, and 30*s.* a week while in London. The

results of the teachers' examination will not be published. Each candidate will be informed of the position in which he would have been placed had he been examined as an ordinary candidate for honours. If he wish his success recorded it will be done in the ordinary way.

6. The biology course will commence on the 14th June, and the course on experimental physics on the 5th July.

7. It must be understood that no teachers except such as come up under the foregoing rules, will have travelling allowances under section 68 of the Science Directory. No persons are eligible to receive the allowances granted by this minute except those who have been engaged in science teaching under the Science and Art Department during the session 1870–71.

6051. You have put in the minute of the Committee of Council, dated the 30th December 1870; that minute, I believe, describes what it is proposed to do with respect to training teachers during the present year?—Yes.

6052. In what respect does this scheme vary from that of previous years?—In principle not at all; in extent, it differs somewhat, inasmuch as it takes up two specific subjects comparatively new.

6053. Does it increase the length of training which each teacher will receive?—Yes.

6054. In all the subjects?—In the subjects named in the minute, a six weeks' course in experimental physics and biology. Of course we might have taken many more, but we had to consider what the Treasury would say to the estimate.

6055. Does that mean that each teacher is to be trained during the six weeks?—Yes.

6056. With regard to the subjects which were taken in previous years, the conditions are to remain the same, are they?—No, this takes the place of them; for instance, no teachers of chemistry are to come up this year, but the teachers are to be trained in experimental physics and biology.

6057. Will there be any examination of those teachers after the conclusion of the course?—I apprehend so.

6058. And will the teachers obtain any recognition, either pecuniary or otherwise, upon the results of that examination?—Not pecuniary, but perhaps otherwise.

6058*a.* Is there any intention of making the examination of the teachers at large, whether they come up to those courses or not, more stringent than it is at present?—There is nothing of that sort I think at present under consideration.

6059. A question was asked you as to the desirableness of inspecting science classes by means of the persons charged with the inspection of elementary and other schools. Do you think it would be possible amongst the class of persons who now inspect such schools to find competent examiners in science?—It is most unlikely.

6060. Could you suggest any savings in the annual expenditure of your department which might be set against the 40,000*l.* or 50,000*l.* which you think it would be desirable to expend in the extension of the science school buildings?—No, none that I can think of. It would be just so much outlay for the building for the new work. It would of course add much to the efficient working of the Geological Survey if the teaching at Jermyn Street were transferred to South Kensington, and the teaching would be all the better for having special accommodation rather than a provisional one.

6061. Assuming the sum which you consider desirable in order to complete the school to be granted, over how many years do you think the expenditure might be spread?—That is for the Treasury to determine. As far as my opinion goes, if the work is to be done, I think the sooner it is done the better. I should say one year.

6062. If you had the money you could lay it out with advantage in one year?—Certainly, and we know enough about plans of schools to make it a reasonably good work at once, without waiting for more experience.

6063. And until you had the whole I suppose you would scarcely derive any benefit from any portion?—

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17 Feb. 1871.



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17 Feb. 1871.

I think if we had to start a college with the new buildings, which are now nearly completed, and such provisional arrangements as could be made, that to some extent would be a wasteful expenditure; but if the nation is too poor to afford the 45,000*l.*, it is better to do that than not to do anything; but the cheapest and best plan would be to decide to do the thing and to do it at once.

6064. And consequently the 40,000*l.* or 50,000*l.* would not become available until the whole of the proposed additional accommodation was completed?—No, it would not. If you make a temporary arrangement you have the cost of that temporary arrangement, whatever it may be, plus the 45,000*l.*

6065. That would make a total expenditure of about 110,000*l.* besides the cost of the present temporary buildings for the School of Naval Architecture?—Yes.

6066. And that would be without any fittings?—This 45,000*l.* included the fittings.

6067. Would the 45,000*l.* also include the fittings for the present building, which is being erected at an expense of about 66,000*l.*?—That is provided for in the 66,000*l.* already voted and incurred.

6068. Are the laboratory fittings included in that?—Yes.

6069. And you have no reason to think that that expenditure will be exceeded?—No, none.

6070. Are they contracted for?—A considerable portion. The joiners' work, and some plasterers' work, and so on, has yet to be contracted for; but we have no reason to think that the estimate of 66,000*l.* for the completion of the building will be exceeded.

6071. Have you read the evidence which has been given before this Commission with reference to the working of the existing elementary science schools?—No; I have only read my own evidence.

6072. (*Chairman.*) Many questions have been put to you as to the probable sources of the supply of students to the proposed training college for scientific teachers. Might I venture to bring under your attention, with a view to correction from you if your experience enables you to contradict it, the following sources of supply—that the candidate for admission by a matriculation examination should have had the training of a pupil teacher in an elementary day school with some knowledge of science, or that he should have been what has been in the country denominated a candidate teacher in a scientific evening elementary school, or that he should have been a student for two years in a training college; and should wish to super-add both to the knowledge which he had acquired in that apprenticeship, and to that which he had obtained in the training college, a training such as was suggested by Professor Frankland, of nine months in the training college at South Kensington, or that he should have been previously an elementary science teacher, under the existing regulations of the Department in the country, and should have given proofs of zeal and skill, and should be able to pass a matriculation examination, or that he should have been previously an elementary day-school teacher, but should have preferred to devote his future time mainly to scientific teaching, or that he should be a self-taught student with a great desire to apply what knowledge he had acquired to the instruction of others, and so, having such a previous history, that he should come up to pass a matriculation examination; would you think those to be probable and legitimate sources of students for the proposed training college?—I think that that enumeration nearly exhausts all possible cases, and I think it would be quite proper to begin, at least, by exacting those conditions.

6073. When you said previously, somewhat demurring to the questions put to you as to the guarantee which should be taken after a large expenditure by the State on the training of students in the scientific training college at South Kensington, that you relied somewhat upon receiving the students from some such sphere, I suppose you mainly depended upon the evidence given of a tendency in the student's life which

led him to devote himself to teaching?—Yes; I think that would be as good a guarantee as you could exact.

6074. And I understood you to draw a marked distinction between a person having such a previous history, and one who came out of the colour shop of a manufactory, all of whose previous training had been connected with commercial business?—I think that you could in practice make a marked distinction, and you could make regulations by which the State would run a risk in one case and none in the other, and yet do service to both.

6075. Taking the class of candidates for instruction which I have described, and the fact that they passed a matriculation examination of gradually increasing stringency in successive years, what length of training do you contemplate as likely to fit them for such functions as might have to be discharged say 10 years hence?—That is a mere speculation. I can conceive that you might do good service by keeping a man a single year, but that has to be tried, and it will very much depend upon the demand of the market. At the present time, in our Art schools the demand of the market for art teachers is such that we can hardly keep a man who has taken two out of six certificates; he goes away taking two certificates, whereas he ought to take six if he were trained thoroughly. In the same way, a Science teacher, if he is to teach two or three subjects as a teacher, would require to stay two years or three years, and yet (though I do not quite expect it, still it is quite possible that there may be a similar demand) he might go away after having stayed only one year, having mastered and got only one subject.

6076. Does not very much depend upon the peculiarity of the institutions in the district from which the student came, and to which he might be disposed from local association to direct his attention in the applications of science to the industry of that district; as, for example, if a student came from a mining district, he might need instruction in physical geography, geology, applied mathematics, mechanism, machinery, and perhaps some chemistry; in order to pass through a course like that more time would be required than if he sought instruction only in a couple of branches?—That would depend upon the qualification with which he came up. I think you would not be able to lay down very marked lines of definition as to how long a man should remain in training.

6077. On the question of method, and the necessity of a student's acquiring a knowledge of the principal scientific laws of teaching, and some skill in the art of applying those laws, would it not be easy in London to give the students, under qualified superintendence, opportunities for teaching in the local science schools in London?—Yes, that might be part of the system; it is part of our system in teaching drawing and painting that the student has to attend a certain number of elementary schools in the metropolis, and that is the practice that he gets.

6078. So that upon reflection you would see no very great difficulty, but in fact abundant facility under skilled direction, in not merely giving the students an acquaintance with the laws that govern scientific instruction, but also practice in the application of those laws?—I think it is quite possible to make that part of the course, and to find this practice in London which would be very applicable to the public out of doors.

6079. Is there anything that you would desire to add to what you have already stated to the Commission?—Not upon the subjects already touched upon. Upon the museum question, if the Commission goes into that as a part of public instruction in science, I should like to speak at some future time.

6080. (*Chairman, to Captain Donnelly.*) The Commission would desire to know whether there is anything which you would like to state to them arising out of your perusal of the evidence which has been presented to the Commission, either in the way of comment upon the evidence of the witnesses, or by way of correction?—I have only looked over



a small portion of this evidence, several points have struck me, some apparently mistakes in statistics. It is rather difficult for me to go over points, for I am afraid I should weary the Commission in enlarging upon what may wrongly strike me as worth referring to. There are one or two mistakes, however, which I should like to correct; but otherwise I would suggest that it would be better if the Commission would call attention to those points which they think of sufficient importance for me to put in any correction or explanation of.

6081. Will you state those points which you think to be the most important?—I will give an illustration question and answer No. 1616 in Professor Fleeming Jenkin's examination. He has evidently, from his answer, got entirely wrong with regard to the facts and statistics of the annual report from which he quotes. In his examination he dwelt very strongly on the advisability and the necessity for encouraging mechanical drawing. Professor Huxley asked him, "I presume, from what you have said, that you do not think that the conditions laid down by the Science and Art Directory which provide instruction in machine construction and drawing are at all adequate to encourage drawing of that sort?" The answer is, "It is impossible to exaggerate their inadequacy. I have got a few figures with me which will explain that inadequacy. In 1867,"—taking his first point, and of course going back to 1867, or rather what it really is, the instruction in 1866 gives a very wrong idea of what is doing at the present moment; the statistics, as far as they go, referred to what happened in 1866,—Mr. Jenkin says, "In 1867 there were 17,210 students who learnt free-hand drawing in the government schools." That is incorrect, because it does not take in night classes, but that is unimportant. "There were 105,695 taught drawing through the agency of the Department; there were 6,583 teachers who received certificates of competency in free-hand drawing." I do not know what that means, because there is no such number that we know of, of men having received certificates of competency in free-hand drawing. The outside would be 1,500.

6082. (*Mr. Samuelson.*) I suppose he meant art students of every kind?—But then there are nothing like 6,000. He says, "who received certificates of competency in freehand drawing." There is evidently some great mistake there. "That may perhaps meet the requirements of the country in free-hand drawing. Now for mechanical drawing. There were 13 teachers as against 1,583 who received certificates." In the first place it is evident that Mr. Jenkin has entirely left out from those figures the mechanical drawing, which is taught as a science subject. I do not know where he gets the 13 teachers teaching mechanical drawing, because it was taught, I believe, in every Art School, more or less, and there would be something like 90 at that time. Taking mechanical drawing as a science subject, there were 52 classes in that year which taught descriptive geometry, 43 classes which taught mechanical and machine drawing, and 27 which taught architectural drawing, so that I do not know what that 13 refers to at all, or where it comes from. "There were 20 schools received assistance because they taught drawing and such teaching!" Now I do not know at all where that 20 comes from. There were a great many more science classes than that, and there were of course infinitely more art classes at that time. "The payments for results were 34,851*l.*, paid to encourage free-hand drawing." That is a curious mistake, and I could not at first find out how it arose. It seems that there were 34,851 payments made of 1*s.*, 2*s.*, and 3*s.*, and also 10*s.* on account of elementary work. The number of payments have been added together, and he has taken the total, 34,851*l.*, as 34,851*l.* paid to encourage free-hand drawing, whereas I believe the total payments on account of art altogether were only 7,306*l.* Then he stated that 340*l.* were paid to encourage mechanical drawing. In the art division it has never been taken out how much of the payment

is given for mechanical drawing, but on the science side during that year there was something over 2,000*l.* paid for mechanical drawing. Mr. Jenkin goes on to say, "If you happen to hold the opinion that I hold that mechanical drawing is much more important as a means of training to the working classes, you can imagine my anxiety to arrive at something exceedingly different from that. Then the total payment on results for scientific education was 5,000*l.* as compared with 34,851*l.* for free-hand drawing alone, and I do not think that drawing is so much more important than science." As I have pointed out the figures are entirely erroneous. I thought it might be worth while to point out to the Commission that really very great efforts are made to encourage that particular branch of instruction. It begins with the art division, where you have practical geometry in three stages, of which I have examples here,—the first grade, the second grade, and the third grade—with the elements of architecture and perspective. Payments are also made in art night classes for the drawings made by artisans, and all descriptions of mechanical and architectural drawing. Then in the science division, which as it were takes up the subject from that point, there are very large classes (it has always been a very favourite subject) in practical, plane, and solid geometry, in machine construction and drawing, and in building construction and drawing. The totals last May were these:—There were 257 classes in practical, plane, and solid geometry, with 6,413 students under instruction; in machine construction and drawing there were 247 classes, with 6,000 and odd students, and in building construction and drawing there were 726 classes, with 5,000 and some odd hundreds.

6083. Can you refer to the reports of the examiners upon this special subject?—I think those reports were put in evidence.

6084. Will you just read briefly what they state as bearing upon this subject?—I have before me the 17th report, namely, that for the year 1870, and at page 63 there is this passage:—"The examination in practical geometry has been as satisfactory as can perhaps be expected till geometry, in the most comprehensive sense of the term, is more studied in schools and colleges than it is at present in this country. The adherence to Euclid as the sole authority on this science, however well calculated that work may be to foster intellectual judgment among the more educated classes, prevents the proper attainment of that branch of mathematics which is most important to all who are intended to practise any of the arts of construction. This is due to the unattractive form in which that great work is arranged, more especially as regards the 5th, 11th, and 12th books. Now for such students a knowledge of pure theoretical geometry of a more advanced kind than is comprised in the 'Elements' is absolutely necessary. In England there are few works which contain this extension of the sciences; while on the continent, where Euclid has long been discarded, there is an abundance of excellent works purposely framed to inculcate all the knowledge required by practical men. The instructors in the various science schools and classes are generally inefficient from the want of this more extended knowledge; they consequently teach their pupils empirical and very objectionable constructions, which are not only more circuitous than authentic ones, but are also calculated to retard any advance in sounder knowledge among their scholars. Certainly these instructors may plead in excuse the want of a sound elementary work by which both to learn and to teach geometry. Of course among the candidates, there are many not deserving of these strictures, who show a sound knowledge of geometry rightly applied, and whose constructions are consequently both accurate and unobjectionable. Having on several former occasions pointed out the causes of the numerous failures of candidates in subjects II. and III., and observing that these defects are as glaring as

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ever, I must emphatically state that the instruction in these subjects must be most objectionable and defective: the candidates generally are not taught the essential principle upon which accuracy of drawing is based, that in order to ensure that accuracy, the central line or 'axis of symmetry,' of not only the larger but also of all the subordinate parts of any work of construction should be first drawn. Further, the candidates seem to have no exception that the plan, elevation, and section of the same object should be co-ordinated according to the first principles of solid geometry. These obvious principles of all mechanical and architectural drawing are flagrantly neglected by the candidates. Their drawing is in consequence worthless and discreditable. A very slight inspection of the candidate's work shows that by far the greater number have no knowledge of what they are drawing, either as regards its use or construction, and that they have been taught only to copy bad diagrams set before them. While so employed they receive no instruction on the use or the construction of the piece of mechanism, or part of a building, the relative proportion of its parts, or the materials of which each part is made; the learner only copies the figure before him as so many lines. These remarks more especially apply to subject III. I believe the candidates often do not know a brick wall from a timber framing, and generally show far greater ignorance of the construction in this subject than they do in machinery. But it is necessary to state that in both subjects there are exceptions; in many cases the drawing is excellent, and a fair knowledge is indicated by the candidate's work. The candidates often neglect the conditions of the examination papers, and instead of completing a few figures well they attempt several which are commenced and left imperfect, thus forfeiting much of the credit they would otherwise be entitled to."

6085. Have you any reason to believe that that is not a fair description of the actual results of the science teaching of the Department, or to dispute that statement?—Not at all in that subject certainly. I might point out at the same time that in the year 1859, when the Department commenced to encourage instruction in this subject, we were told on the very best authority that there was no class in the country where an architectural draughtsman or a machine draughtsman could be taught his art except in a machine shop or in a draughtsman's office; and certainly we did not know of any class existing where such a thing as descriptive geometry was taught at all. Of course there is a great deal of inefficient instruction being given, and it is the examiner's duty to point out as strongly as possible that it is so; but you must remember that there are a great number of classes where a great amount of efficient instruction is being given, and the proof of that is the number of persons that the examiner, who makes these strictures, does at the same time pass as having been fairly taught. (*Mr. Cole.*) In 1852 it was not thought a proper thing to teach carpenters and joiners, and there is a minute on the records of the office, made by Mr. Porter, that it is no part of the business of the school of art to teach carpenters and joiners geometry at all. We always had the flavour of science before we called it science.

6086-7. What was the proportion of successes and failures in those three subjects?—(*Captain Donnelly.*) Of course the people who do not pass are no worse off than before, when they were not taught at all; but of those who were taught and passed in the advanced stage of practical, plane, and solid geometry there were 49 per cent. in the 1st class and 22 per cent. in the 2nd class, and 28 per cent. of failures. In the elementary stage there were 19 per cent. successes in the 1st class, 13·7 per cent. in the 2nd class, 13 per cent. in the 3rd class, and 54 per cent. of failures. In machine construction and drawing there were in the advanced stage 6½ per cent. 1st class, 42½ per cent. 2nd class, and 50 per cent. failures; and 13 per cent. 1st class, 17½ per cent. 2nd class, and 23 per cent. 3rd class, and 46½ per cent. failures in the elementary stage. In building construction there were 13 per

cent. in the 1st class in the advanced stage, 39 per cent. in the 2nd class, and 47 per cent. failures. In the elementary stage, there were 6½ per cent. 1st class, 14½ per cent. 2nd class, and 27 per cent. 3rd class, and 51 per cent. failures, the numbers being very large.

6088. Is it not the case that the greater number of passes have been in certain schools and districts, and that a very large proportion of the failures have been in certain other schools and districts?—Yes, and of course that very soon cures itself, because if a man finds that he cannot make anything out of the teaching we find that he gives up trying.

6089. (*Chairman.*) Is there any other point upon which you would wish to furnish the Commission with corrections of the evidence which has been given?—There was a point in the same evidence of Mr. Fleeming Jenkin with regard to the higher scientific instruction. In answer to question No. 1613 Mr. Jenkin says, "In founding the new chairs to which I have alluded you might say, I will pay you for the next five years such a salary, and at the end of that time if you do not have an average attendance of so many pupils I shall consider that the chair has failed, and your appointment will come to an end, and that might be continued from five years to five years, taking the number of pupils who are willing to pay the fees as a real test of the utility of the chair." I should say that as a method of practically working a government system that would be impossible to carry out. If the number of students fell a few short it would be absolutely impossible to withdraw the salary, nor do I believe it would be possible in any case to withdraw a professor's salary after he had been working for five or six years. You would have such an outcry against the public department that they would not dare to do anything of the kind. I think this question came up on a previous occasion when Mr. Cole was being examined as to the proposition made for aiding higher scientific instruction by the Department. It was then stated that we thought the best way was to grant exhibitions and scholarships to the students, carrying with them the payment of fees, and to allow the student to select the place where he would go within certain limits; such limits, for instance, as that the State department should keep a list of the places at which the exhibition might be held. The plan would thus work itself out according to the goodness of the teaching, which would as a rule be the reason why the student would select one college in preference to another. There is one other point I may refer to. At question 340 I think Mr. Samuelson asked Professor Huxley a question from which apparently a portion of my memorandum has been entirely misunderstood. Mr. Samuelson says, "You would not approve, I suppose, of the suggestion contained in Captain Donnelly's paper of the 12th of November 1867, with reference to the teaching of science in elementary schools, that the Science and Art Department should make a return of the results to the Education Office, and that the function of the Education Department should simply be to pay upon those results." I would say that the mischief of the question (as the lawyers say) lies in the word "simply,"—that the Education Department would simply have to pay upon results. My proposition was "that probably it would be advisable that the payments should be made through the Education Department, who would then have full control of the matter." This was carrying out very much the same principle as had been in force with regard to art; the certificate payment to the masters teaching in the elementary schools which they earned on account of art instruction was made through the Education Department, so that the Education Department—the other branch of the office—had full control over their teachers, and knew exactly what they were earning from both sides. That prevented the ill effects of the teacher serving two masters, one of whom was ignorant of what the other was doing. Of course somebody must employ the examiners, and according to my proposal the examiners would continue to be as



they are now, employed by the Science and Art Department, but the action of the two departments would be in harmony.

6090. You would think it applicable to every class of teachers that they should acknowledge one and not two masters?—Yes; and it is merely a matter of arrangement between the two branches of the office.

6091. (*Mr. Samuelson.*) What would the function of the Whitehall Education Department really be?—The payments would be made only through them. They would have full control over their teachers, and there would be no liability of the one department seducing away a teacher from his proper work under the other.

6092. (*Chairman.*) The same thing would apply, for example, to any inducements to the study of science which might be offered by the Science and Art Department, that they should all come under one great education department?—Yes, certainly.

6093. And receive the approval of the education department both in their initiation and in their progress?—Yes. As it is at the present moment we make a return, as far as we know, of the payments to the elementary school teachers that have been made through our Department. What I proposed was only carrying this principle a little further, so that the administration might be more perfect.

6094. In the same way if there were superadded to an ordinary elementary school a superior elementary school, and that superior elementary school distinctly undertook the instruction in elementary science in a more positive manner than may be possible in a purely elementary school, that would come under the cognisance of the Education Department, whatever aid they sought from the Science Department in the way of advice or assistance?—Yes.

6095. (*Mr. Samuelson.*) What would be the functions of the Education Department besides simply paying upon results in that case?—They have no functions; but that branch of the office does not profess now to pay for science instruction. The only question is whether the payment should be made by one department directly to the teachers without the cognisance of the other department under whom they are more immediately acting, or whether it should be made with their cognisance and under their control.

6096. Then what is your ground for finding fault with the question?—That I think it gives an entirely wrong impression of my recommendation. My recommendation was not that the function of the Education Department should be *simply* to pay upon results.

6097. What else would their function be?—My recommendation was that the Education Department should have the control of the teachers. I never proposed that the Education Department should pay at all in science.

6098. Will you be kind enough to state what your proposal was?—“Probably it would be advisable that the payment should be made *through* the Education Department,” exactly as has been done with regard to art.

6099. (*Chairman.*) Have you any other point which you wish to bring to the notice of the Commission?—In a great number of questions and answers, especially Professor Huxley's and Professor Ramsay's, there seems to be an idea that the teachers who were especially remarked upon by them as teaching badly, were necessarily or largely those who have obtained their qualification for earning payments on results since the November special examination for teachers had been abolished. I see that both Professor Huxley and Professor Ramsay stated that they did not know who the specific teachers were whose papers they commented on; but there seemed in their evidence to be that kind of impression, and so I had the cases looked up. I also had this done with respect to all the special reports there were about cramming. I have here a return of the most successful and the least successful teachers in animal physiology; and, as far as these returns go, to show anything, they show that there are quite as many good teachers who

had obtained their qualification since the special examinations were done away with as there were good teachers who had obtained their qualification before; and, on the other hand, quite as many who taught badly who obtained their qualification when that special examination was in force. As bearing upon the point of cramming, let me call attention to Mr. Ramsay's evidence. He says that he remarked specially that several sets of candidates, which he supposes were from different schools, were very unsuccessful, and were very badly taught. When I looked into their cases, I found that the first was taught by a gentleman who had received an honorary certificate, as being eminently qualified as a teacher of geology. The next set were taught by a teacher who had no qualification, and merely came up for prizes. The next four schools reported upon by Professor Ramsay, of one of which he says in his evidence that of 49 candidates 26 were unsuccessful, and in his report to the Department, “there are strong symptoms in a considerable number of the answers of their having “learned by rote;” of another “this lot very unsatisfactory,” and of another “36 candidates all unsuccessful,” happened to have been all taught by one teacher, who was an Associate of the Royal School of Mines. I merely bring this forward to point out that there is no connexion between the ability of the teacher and the examinations he has passed, and the amount of cramming that he may give his students, further than that the more able the teacher the better he can cram, if he wishes it, and therefore no amount of preliminary examination of teachers will in any way prevent cramming. One must only look to the examiners examining the students properly, to prevent that practice increasing.

6100. But you would hope very much more from such improvements as you contemplate to be consequent upon the foundation of your training college for teachers?—Not in the way of preventing cramming. I believe the more efficient you make the teacher the more he can cram if he likes. The most eminent crammers at the Universities are men who have taken the highest degrees.

6101. (*Marquis of Lansdowne.*) I understand you to say that the better the teacher, and the more examination preceded his appointment as teacher, the more able he was to cram; would you equally say that the more likely he was to cram?—I should not say that he was more likely to cram, but I should say that he would be just as likely to cram. An able man has more capacity for cramming, because he is more able to judge of the specialities of the examiner, and to work up to them.

6102. (*Chairman.*) But does not that arise to some extent, under existing circumstances, that he has to teach pupils who are imperfectly prepared, that the period of teaching is limited, that his hope of remuneration is on their passing a given examination; and all these circumstances connected together form rather a powerful incentive to cramming, the moral qualifications being absent?—Yes; but the incentive is the same to all, and I think that the men who most probably would do the cramming would be the men who could do it easiest, and the ablest man will do it much more easily than a man who is less able. As a matter of fact, that is borne out by all our returns; we find that the cases of really bad cramming are often by men who are quite the ablest. It is in the power of the examiner of the pupils alone to check cramming.

6103. (*Professor Stokes.*) An able man may cram if he is perversely disposed, but a man who is crammed himself can do nothing else?—Quite so. Then of course the great advantage of payment on results is that that man will not gain any results if we have a proper system of examination.

6104. (*Chairman.*) Is there any other point that you would wish to mention?—When I was examined before there was a question with regard to the ages of candidates. I have had a table made out from the last year's book of the ages of the candidates, the number

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Donnelly, R.E.

17 Feb. 1871.

examined, the number successful, and the per-centage of successes in the numbers examined. It is rather an interesting table. We begin with eight years and upwards. There were 29 candidates who were eight years old at their last birthday; of those five were successful, or 17 per cent., and so it runs up. 29 came up at eight years of age, 142 at nine, 599 at 10, 1,397 at 11, 2,572 at 12, 3,007 at 13, 2,876 at 14, 2,654 at 15, and so on, the largest numbers coming up being between 12 and 23 years of age; from that point the numbers begin to diminish. The greatest per-centage of success is somewhere about the age of 19 to 23, where we run up to 62 per cent. and 61 per cent. Then we run up to two people who came up at 60 years of age, neither of whom was successful, and two at 58, one of whom was successful. This table shows that the bulk of the successful candidates are from 10 to 21 years of age. (*The witness delivered in the following table:*)

AGES of CANDIDATES, May 1870.

Ages.	Number examined.	Number successful.	Per-centage of Successes in Nos. examined.
60	2	—	—
59	—	—	—
58	2	1	50
57	—	—	—
56	—	—	—
55	4	—	—
54	4	3	75
53	6	2	33·3
52	5	1	20
51	5	2	40
50	12	7	58·3
49	13	9	69·2
48	6	3	50
47	21	12	57·1
46	18	13	72·2
45	30	14	46·6
44	31	15	48·3
43	33	19	57·5
42	48	26	54·1
41	34	20	58·8
40	58	31	53·4
39	63	41	65·07
38	86	39	45·3
37	93	49	52·6
36	128	61	47·6
35	127	75	59·0
34	172	93	54·0
33	157	84	53·5
32	209	127	60·7
31	268	148	55·2
30	393	218	55·4
29	350	203	58
28	425	262	61·6
27	400	234	58·5
26	512	305	59·5
25	738	438	59·3
24	832	479	57·5
23	1,016	579	56·9
22	1,104	660	59·7
21	1,476	909	61·5
20	2,103	1,315	62·5
19	2,682	1,672	62·3
18	2,684	1,530	57
17	2,270	1,175	51·7
16	2,440	1,251	51·2
15	2,654	1,277	48·1
14	2,876	1,274	44·2
13	3,007	1,164	38·7
12	2,572	890	34·6
11	1,397	451	30·9
10	599	175	29·2
9	142	34	23·9
8	29	5	17·2
Total	34,336	17,395	50·6

A minute has lately been issued with regard to assisting with apparatus the chemical classes, and it may be interesting to the Commission to know that that has been very largely taken advantage of. According to the applications there are 872 students practically working in chemistry. (*The witness delivered in the following paper:*)

Science Form, No. 439.  
South Kensington, February 1871.

SCIENCE AND ART DEPARTMENT of the COMMITTEE OF  
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

*List of Schools applying for the Special Grant in  
aid of Laboratory Expenses.*

TOWN.	WHERE HELD.	Num. of Students.	No. of Sets of Apparatus.
ENGLAND.			
Accrington, Lancashire	Mechanics' Institution	14	14
Bethnal Green, Middlesex	National School	30	30
Bingley, Yorkshire	Mechanics' Institute	—	—
Birmingham, Warwickshire	Midland Institute	33	33
Birstall, Yorkshire	Mechanics' Institution	16	13
Bishop Auckland, Durham	Wesleyan School	12	6
Blackburn, Lancashire	Science School	11	11
Bradford, Yorkshire	Mechanics' Institute	6	4
Bristol, Gloucestershire	School of Sci., Redcross St. Athenæum, St. Luke's, Bedminster, Christian Association.	14	14
Cheltenham	Trade and Mining School	24	24
Church, near Accrington, Lancashire	Whitworth Science School	4	—
Dudley, Worcestershire	National School	16	—
Elsecar, Yorkshire	Blue Coat School	5	3
Exeter, Devonshire	National School	2	1
Gildersome, Yorkshire	Science School, Albert Museum	10	10
Grantham, Lincolnshire	Literary Institute	10	—
Guildford, Surrey	Science School, National Sch. Science Classes, Castle Street, Quarry Street.	12	6
Hyde, Cheshire	Science Classes, Castle Street, Quarry Street.	15	8
Islington, Middlesex	Mechanics' Institute	8	4
Kendal, Westmoreland	Sch. of Sci. & Art, Windsor St.	24	21
Kinver, Staffordshire	Sch. of Science & Art, New Rd.	11	10
Leeds, Yorkshire	Science Class, Wire Mill	5	5
"	Mechanics' Institution	20	20
"	St. Peter's School	12	6
"	St. Simon's School	1	2
"	Young Men's Christian Assoc.	24	12
Lindley, Yorkshire	Mechanics' Hall and Nat. Sch.	1	1
London	Royal Polytechnic Institution, Regent Street.	16	16
Maidenhead, Berkshire	St. Luke's Young Men's Assoc.	2	1
Manchester, Lancashire	Grammar School	111	111
"	Ancoats Presbyterian School	12	6
"	Hulme Working Men's Inst.	7	6
"	Mechanics' Institute	66	33
Newcastle-on-Tyne, Northumberland	Elswick Works Mechanics' In.	12	12
Northampton, Northamptonshire	Museum	64	32
Oldham, Lancashire	School of Science and Art	24	24
Pendeen, Cornwall	National School	6	—
Redditch, Worcester-shire	Literary Institute	2	1
Salford, Lancashire	Working Men's College	22	11
Sheffield, Yorkshire	Mechanics' Institute	25	13
Skipton, "	Park Wesleyan Education Ins.	—	2
Slough, Buckingham-shire	Mechanics' Institute	—	—
Stockport, Cheshire	Mechanics' Institute	—	2
Stourbridge, Worcester-shire	Sunday School, Duke Street	12	8
Toddington, Bedford-shire	Grammar School & Sch. of Art.	8	6
Wakefield, Yorkshire	Wesleyan School, Leighton Rd.	13	13
Walsden, "	Mechanics' Institute, Wood St.	14	7
Woking, Surrey	Trinity Ch. Young Men's Asso.	14	7
Wolverhampton, Staf-fordshire	Mechanics' Institute	2	1
"	St. John's School	18	9
"	St. John's School	—	2
SCOTLAND.			
Glasgow, Lanarkshire	Carlton Place Secular School	20	20
IRELAND.			
Ballymena, Co. Antrim	Classical and Mercantile Sch.	6	3
Holywood, Co. Down	Sullivan's School	12	6
Waterford, Co. Waterford	Model School	12	6
Total		872	648

6105. Can you state the whole value of the chemical apparatus as far as it has been ascertained?—There have been 648 sets of apparatus of the value of 2*l.* a set.

6106. (*Mr. Samuelson.*) You give 2*l.*, but they would be worth 4*l.*, would they not?—The whole cost is 2*l.* 5*s.* or 2*l.* 6*s.*

6107. That is the extent of your contribution, but the actual value would be double, would it not?—No, we give the whole in two years.

6108. In your scheme you propose that the instruction in mining and metallurgy should continue to be given at the Royal School of Mines. Have you considered whether instruction in geology might not also



be continued to be given at the Royal School of Mines?—No, I think not. It was proposed in this scheme that physical geography and geology should form one branch of instruction, and it would be probably a very large and important class in the training school. I do not think that there are any appliances at Jermyn Street for proper instruction for such a class. There is no such thing as a class room, where the students can sit and work during the daytime. I think it would be a great pity to separate that very large and important branch from the main school, and take students backwards and forwards from Jermyn Street to South Kensington.

6109. Have you carefully considered the question whether physical geography and geology should be taught by the same professor?—I went over this scheme very carefully with Professor Huxley, and I believe it is generally considered that geology and physical geography, which are so intimately connected, may with great advantage be taught by the same person.

The witnesses withdrew.

HENRY H. SALES, Esq., examined.

6113. (*Chairman.*) Will you describe to the Commission what is the nature of the office which you hold in relation to the Yorkshire Union of Institutes?—I represent to-day the Yorkshire Union of Mechanics' Institutes, of which I am the visiting agent, and the Yorkshire Board of Education, a distinct society, of which I am the honorary secretary. These are county associations which work in cordial co-operation. The work of the Yorkshire Union of Mechanics' Institutes is limited to special institutions. There are 130 institutions in the union. My duty in connexion with the Yorkshire Union is to visit the associated institutes at least annually, to inspect the work going on, to meet the committees, and to make suggestions respecting the work. The object of the Yorkshire Board of Education is generally to promote education throughout the county of York, and its mode of operation is as follows:—Conferences on education are convened in various towns of the county. A conference was held a fortnight ago, the first of a series of conferences on non-educational endowments. Our work has special reference to the education of adults over the age of 12 years; the whole of the local work of the Universities; and the promotion of scientific instruction. We promote scientific instruction by organizing work; by providing the preliminary expenses, and by tabulating results and commenting upon them. That is the general scope of the work in which we are engaged.

6114. In your first function with respect to the mechanics' institutions, have you any duty in relation to the organization of teaching within those institutions by your personal exertions?—No, not by direct teaching.

6115. Do your functions include anything like personal inspection or examination of the students?—Not so much the examination of the students as the inspection of the teachers and the character of the work carried on. Perhaps it would be well that I should take the case of any one institution. On a certain day, mutually arranged between myself and the committee of the institution, I visit the institution and meet its committee, having already received from them their reports for the past year. I go through their reports with them and comment upon them. I then make inquiries respecting the way in which they are conducting their work, and after that I go carefully through the whole of the institution in its various departments, making my own notes thereupon. Having done that, I again meet the committee for them to ask me any questions they may please. I make no report to them. My report is laid before the central committee of the Yorkshire Union as a confidential report, and they remit such portion of it as they think desirable to the institution visited.

6110. With regard to the facility for illustration afforded by the Geological Museum, you do not consider it to be of sufficient importance to outweigh the considerations in favour of South Kensington as a locality for teaching?—As a matter of fact, I believe they have an entirely different set of specimens for lecture illustration, and I believe that they very seldom take geological specimens out of the museum for the purpose of lectures. There is a pretty complete set of lecture illustrations.

6111. You would have your teaching collection at hand for your teachers, and the Geological Museum would still be as open to the pupils as the British or any other museum is?—Yes. I believe that a teaching collection already exists in Jermyn Street, independently of the museum, and which of course would be moved.

6112. (*Chairman.*) Is there anything which you would wish to state with respect to the estimate, independently of any questions which have been put to you?—I do not think there is anything further.

H. Cole, Esq.,  
C.B., and  
Capt. J. F. D.  
Donnelly, R.E.  
17 Feb. 1871.

H. H. Sales,  
Esq.

6116. Does the central board make any grant to the local institutions?—No.

6117. Do they derive benefit in any form from any prize scheme or other arrangement from their connexion with the central board?—Not from the Yorkshire Union. That work has been taken up by the Yorkshire Board of Education, and annual examinations are held by it. Referring to your question with respect to the promotion of primary education for adults, last year the examination was held at 26 centres in Yorkshire. There were 684 candidates examined whose ages varied from 13 years to 36, and certificates were awarded and prizes distributed.

6118. Is it any part of your duty to witness the classes of the institutions in operation?—Yes. On the occasion of my visit I see the work that is going on, and if it is necessary I take a class myself, the special object of my visit being to report fully and thoroughly on the organization in all its details of the class work.

6119. The classes are generally held in the evening, are they not?—Yes, without exception in the evening.

6120. Will you be kind enough to describe the ordinary staff of teachers of the second and third rate mechanics' institutions, at the great towns more particularly?—Within the last few years, owing to the constant representations made by the Yorkshire Union, certificated teachers have been employed, and we urge their engagement strongly upon the institutions; but the great drawback has been the anomalous position of the government towards the institutions in withholding the government grant to those schools which are not connected with day schools. The year before last a large deputation from Lancashire and Yorkshire waited upon Earl de Grey, but he postponed the question until the Primary Education Bill had been brought in, and after it had been brought in, no provision having been made therein to meet the difficulty, representations were made by the Yorkshire Union and the Yorkshire Board of Education to the government. It was suggested that we should wait until the Revised Code was published, which is just issued, but which we have not seen at present.

6121. Is there any State assistance to them?—No.

6122. As respects the number of those institutions in which scientific instruction is given, can you give the Commission any information?—In 1867 I was directed by the central committee of the Yorkshire Union of Mechanics' Institutes to institute an inquiry into the state of scientific education in Yorkshire, and the result of that inquiry I hold in my hand. We found that at that time there were only 14 science schools in Yorkshire, by which I mean schools in connexion with and receiving grants from the Science and Art Department, and in those



H. H. Sales,  
Esq.  
17 Feb. 1871.

14 schools there were only 426 pupils. In the session of 1867 and 1868, immediately after the publication of that report, steps were taken by the Yorkshire Union and the Yorkshire Board in co-operation for the extension of the science classes, and perhaps I may be allowed to mention those steps. We found, in the first instance, that there were hardly any teachers at that time, at least not 12 teachers in Yorkshire who were competent to take science classes in connexion with the Government. We then immediately set about establishing schoolmasters' science classes. We convened conferences of schoolmasters in Leeds, in Huddersfield, in Sheffield, and in Wakefield, the mayors of the towns presiding over the meetings, and we then offered to establish classes on Saturday afternoons for schoolmasters only. A very great response was made to that offer, which was continued the succeeding session and up to last session, until we have found that so far as the ordinary science classes are concerned we have sufficient teachers in the county; that is to say, by our action we have induced certificated masters of primary schools to become science teachers in the sense that the Science Department understand it, and these figures are the results of our work brought up to this week. In May 1868 there were 14 science schools in Yorkshire, with 426 students; in 1869 there were 41 science schools and 1,035 students; in 1870 there were 84 science schools and 2,389 students; and in February 1871, that is only a portion of the year, there were 97 science schools and 2,650 students. But that does not show even the result of our work so much as a comparison of one or two towns. In Bradford in 1866 there were no science schools; in 1870 there were seven with 185 students. In Huddersfield in 1866 there was one school and 26 under instruction; in 1870 there were seven schools and 230 students. In Leeds in 1866 there was one school with 33 students; in 1870 there were eight schools with 465 students. In Hull, leaving out the navigation school, which is a special school, in 1867 there were no science classes; in 1870 there were two schools and 74 students; and these results are entirely owing to the work which we took in hand in the establishment, through the trades' societies, of classes in drawing. In the same way we have convened public meetings of artisans. In Hull in co-operation with the Young People's Institute, the largest institute there, and the amalgamated carpenters and joiners, we established classes in practical, plane, and solid geometry, machine drawing and building construction, and also in chemistry and mathematics. The foregoing are specimens of the result of our work in the large towns, which we fairly attribute to the propagandism we instituted in consequence of the investigations we made in 1867.

6123. Can you give us any further information upon the development of the operations of the union with respect to science classes?—Having established schoolmasters' science classes, and having seen that the science schools organized in accordance with the arrangements of the Science Department were well on foot, we found that there was a deficiency which prominently manifested itself in the science classes that we had already founded. The teachers complained that the lads, for they were all apprentices and young men, came without the slightest knowledge of the subject that they wished to study. In connexion with this fact we also took into consideration another branch of our work, and we found that the mechanical action of the Revised Code was doing a great deal of injury to our primary schools, for although, as a rule, we abstain from action in respect to the primary schools, this was a subject which engrossed our attention, and therefore for two reasons we took up the question of the instruction of children in the elements of science. The reasons we assigned were that the mechanical action of the Revised Code was very prejudicial to the teaching of reading, writing, and arithmetic in the primary schools, and that in the schools where instruction in science was introduced the elementary subjects were learnt better and quicker;

and we also had before us the fact that our science classes could not progress all the while the teachers had such thoroughly crude material, if I may say so, to work with. We therefore proposed to establish in one or two districts classes for the children in primary schools to show the practical results of such teaching. Accordingly we called together the schoolmasters of Sheffield. If you will allow me I will read a short extract from our report upon that point:—"This step was taken in order to provide a body of qualified science teachers who should promote instruction in the rudiments of science in the primary schools." A meeting of schoolmasters was held, to which I have referred, and a class of inorganic chemistry was established. "For 30 weeks the elder boys of the primary schools in Sheffield were assembled on one evening each week for the purpose of receiving instruction in the rudiments of inorganic chemistry."

6124. (*Professor Huxley.*) Could you state the age of those elder boys?—From 10 to 15. The report proceeds thus:—"The object the council desired to accomplish was to awaken in the boys an interest in the subject which in so many cases will enter into their future labour, and thereby to create a desire for fuller acquaintance with it, thus substituting for the 'rule of thumb' an intelligent knowledge of the principles of their work." The result of my inquiry (*vide* Question 1221 of Report) into the state of the artisans in the manufactories of Sheffield, as regards their scientific education, was such that I found they were totally unacquainted with the scientific principles involved in any branch of the work in which they were engaged.

6125. (*Mr. Samuelson.*) Do you speak of the manufacturers as well as the managers and working people?—I speak generally. The report proceeds—"112 boys formed the class, which was most carefully taught by Mr. G. Harrison. Measured by the examination standard of the Department of Science and Art the amount of knowledge gained was considerable, for no less than 26 passed in the annual May examinations of the Department." I should like to direct the attention of the Commission to the following extract: "But the testimony of the parents, shown in their great interest for the advancement of their children, is far more conclusive respecting the value of the class. We have found great interest arise among men who were totally unconcerned about the matter before;" and still more important is the evidence of the schoolmasters, who have unanimously expressed their opinion that the class lessons have developed the intelligence of the pupils, and created in them a love for instruction in the rudiments of science." The result of the publicity given to the instruction of school children in the rudiments of science is, that science is being taught in our ordinary primary schools. The establishment of the trade school at Keighley is in no small degree due to the same cause.

6126. (*Chairman.*) Can you say from any record or personal knowledge to what classes of society those boys belong?—To all sections of the industrial classes and of the manual labour class. At St. Peter's School, Leeds, there are very few boys that are over 14 years of age, but there are some up to 15.

6127. (*Professor Huxley.*) At what age do you begin teaching science?—From 10. We have now a pupil teachers' science class established at Leeds, but we have found that our operation is better confined to organizing. As soon as we can get somebody else to do the work we withdraw and turn our attention to the development of some other branch of educational work. With reference to the establishment of the Keighley trade school. At Keighley there has been a very old mechanics' institution. The manufacturing industries of Keighley have very largely increased during the last few years. The Keighley trade is the same as the Bradford trade, the worsted manufacture. I was sent for by the Committee to advise them with respect to the plans of their new institution, they being about to erect a large building at a cost



of something like 12,000*l*. In conversation with them I pointed out the facts which I have named to the Commission, that their adult evening classes could not succeed while the material was unprepared for them, and that having the resources at their disposal they should establish a trade school adapted to the requirements of the district. The suggestion was taken up and duly considered. In the autumn of last year the Duke of Devonshire opened the institution, and the trade school commenced last month. The trade school is divided into two parts: an ordinary English education, with a few branches of the rudiments of science is taught in the lower portion, and in the higher part of the school more advanced instruction in science is given. We hope the pupils will be led on from the trade school to still more advanced classes for technical education in the evening. It is too early to speak at present of the results, but we look for great results from the movement, and moreover we anticipate that the establishment of the school will lead to the establishment of other schools in the county, for others of our institutions are preparing to do the same work in degree.

6128. (*Chairman*.) To what classes do the scholars belong?—They belong to the upper manual labour class. I do not mean unskilled labourers, but skilled workmen, overlookers, the sons of manufacturers and shopkeepers, the higher mechanics in fact.

6129. With respect to the science classes generally, in teaching subjects of experimental science, are the teachers ordinarily provided with apparatus for illustration?—They were not until within the last 12 months. The system of the Science and Art Department has led to a great deal of cram, and thus physics and chemistry have been taught without any apparatus or laboratory or anything of that kind, but purely from books. I recall two or three cases where we know for a certainty that the examinations have been passed and the pupils unable to perform the slightest experiment.

6130. Do the teachers themselves ordinarily acquire any skill in manipulation?—Ordinarily they have done so.

6131. But they have no apparatus with which to illustrate their work?—The Science and Art Department has made a very excellent rule now of refusing to give the full amount of grant unless the class is provided with apparatus. This has caused representations to be made to us by the science teachers as to the injustice of the proceeding, but we consider on the other hand that is so exceedingly proper that on this point we cannot take the part of the teachers.

6132. Does that apply to the chemical classes only, or also to others?—To others also.

6133. Does the Department, for example, require, that in teaching geology and botany there should be specimens from which to teach?—I cannot say, for we have no classes in geology or botany.

6134. In what classes then is apparatus used now in illustration of the teaching?—In chemistry, magnetism, and electricity. Those are three classes which occur to me at the moment, and to which my remarks have specially referred, as to there being an absence of apparatus, and in which we certainly think that the subject cannot be properly taught without apparatus.

6135. The teaching is illustrated, but the students, I apprehend, have no opportunity of manipulation?—They have not had hitherto.

6136. In what mechanics' institution in the great towns is there any opportunity afforded to the students for any manipulation?—There is a very fair laboratory at Leeds, I may say a very good one, compared with provincial laboratories, and the students avail themselves of it largely. The Chemists' Association supply a number of students to the class.

6137. To what classes do the students belong?—I should say that one half would be apprentices to chemists and druggists.

6138. Are there any connected with the dyeing trades?—Yes, a great number.

6139. Is there any other mechanics' institution

which has a laboratory for experimental physics or chemistry?—There is a fair one at Huddersfield, a very good one at Keighley, and also at the Haley Hill Working Men's College at Halifax. At the moment that is all that occur to me that have any pretensions at all to a laboratory.

6140. In the smaller mechanics' institutions throughout the country of course there are none?—No.

6141. To what extent is the remuneration for the teaching of science derived from the Science and Art Department, and to what extent from local resources?—We find that at present in our classes for the manual labour population it is impossible to charge a higher fee than 5*s*. for a course of 30 lessons. The sermon that I preached up and down through Yorkshire in establishing those classes was that the institution shall provide the room, the fire, and the light, and now added to that I say they must provide also laboratories; but at first that would have frightened them altogether and we should not have got them on foot. In a few cases, but in those cases we have strongly opposed it, a portion of the government grant has been taken by the institution for the purpose of defraying the expense of lighting, and so on.

6142. So that in some cases the government grant has defrayed all the expenses whatever, and in others it has defrayed the entire remuneration of the teachers?—Yes.

6143. The science teachers are, therefore, in all but the great towns, simply dependent upon the payment for results by the government?—Entirely.

6144. Is there any hope that the sciences of observation, botany, and geology, and so on, will be more cultivated in Yorkshire?—Yorkshire people look in the first place at what is going to pay, that is my experience; they will not look at anything unless it is going to pay, that is their axiom. But we have found that latterly there have sprung up field clubs in connexion with the institutions. There is a good one in connexion with the Young Men's Christian Association at Leeds. I say good, comparatively, for such an institution, and we look forward to botany and zoology being extensively studied in the future, as there are indications of it at present. Perhaps you will allow me to say here, that the Yorkshire Board of Education do not think that it is right to confine its attention merely to the manufacturing value of scientific instruction, but we also consider that it is desirable in our manufacturing districts to promote a knowledge of domestic physiology and the laws of health; and accordingly we have made arrangements, which would have been carried out this spring, only other work was so pressing, but which we shall carry out in the autumn, of having courses of lectures in our large towns; and we have secured the promised co-operation of the medical profession to give those lectures. This brings me to one most important part which I should very much like on behalf of the county to urge upon the Commission in the strongest manner possible. At the present time we have no men of any scientific attainment resident in the county of York. We found a strong disposition on the part of those who cannot attend the classes, I mean the adult artisan and the skilled mechanic, to obtain some insight into his work, and accordingly we thought that it would be well to do in Yorkshire what is done in London, namely, to establish lectures for the benefit of those men. We accordingly called a conference of trade societies, first of all in Leeds, and we had representatives present from 40 of the trade societies. We are not connected in any way with trade societies, but we work with any society that shows an interest in our operations, and their organisation is so complete that we find it useful. We said that we were prepared in co-operation with the committee of the Leeds Mechanics' Institute to have a course of six lectures on science as applied to the industrial arts; that we would undertake to bear all the expenses of the lectures, the Leeds Mechanics' Institution finding a suitable room for the purpose, and that they were to find the audience. We found a very great willingness on their part. I

H. H. Sales,  
Esq.  
17 Feb. 1871.



H. H. Sales,  
Esq.

17 Feb. 1871.

am now speaking of the trade societies representing the better portion of the skilled mechanics. We then had to consider whom we should get to deliver the lectures. We applied to the Science and Art Department, and we received the reply which is commonly received in the country, that there was no precedent for sending lecturers into the country. We said that inasmuch as it would be far more advantageous to the nation for lectures on mining and mineralogy to be delivered in the place where the people were to work than to clerks in London (not that the Yorkshire people at all wished to debar the Londoners from those lectures), we thought that we ought to have some assistance inasmuch as we had not sufficient funds, for in a voluntary association we have not command of unlimited funds, and we refused to ask Professor Roscoe and other professors from Owens College to give gratuitous lectures, because we think that we have no right to tax them to do so; but being unable to get any assistance whatever from the government we were thrown on our own resources. We organized six lectures, two on the formation and consumption of coal, two on the elements of mechanics, and two on the chemical action of water, and we took three of our own men, excellent men, but not of course of such scientific attainments as the men we desired. 280 men purchased sixpenny tickets in Leeds, and there was an attendance of never less than 250 of those men, who, towards the latter part of the course, on the 5th of April and the 12th of April, came direct from the workshops into the lecture room; and I can say, from attending each of the lectures, that those men paid the strictest attention; it was impossible to find an eye off the lecturer or a listless ear in the room. The success we considered to be very great indeed, and we only regretted that we could not do it more efficiently than we were able, but we hope to do so when we get what there is fair hope of our getting, our Yorkshire College of Science established. But the point I want to bring before the Commission is this, that these lectures upon the sciences as applied to the industrial arts of the district are required in the district, and the only obstacle to that is, we have not the funds to employ proper men to deliver them, but the funds and the men are in London, where there are not the people whose daily avocations require they should receive such instruction.

6145. In fact, speaking of the employers of labour generally in Yorkshire, would you expect to derive any very large amount of assistance from them at present towards the development of such and similar schemes?—I can speak in the highest terms of the co-operation which we have received from the manufacturers of the county, and their willingness to co-operate in every way; but then we are met by this feeling, that they are already contributing to the Government funds, of which they receive but a very small benefit in the localities. We intended to get a guarantee fund so as to engage Professor Roscoe or some other professor, but we were met by this question—"This is being done in London by the government, and why should it not be done also in the country; why should we be at the expense?"

6146. But taking a case in which the government does contribute, as, for example, to the teachers of elementary science, you have told us that those teachers are absolutely dependent at present for their remuneration upon the government; do the employers of labour in this district contribute to the fire and light of the mechanics' institutions in any very great degree?—They contribute to the support of the institutions generally. The fire and light is not separated from the general expenditure under those heads in the institutions, and they contribute largely to the support of those institutions.

6147. Do they contribute for such purposes as the general elementary instruction, the newsroom, and the other objects of the mechanics' institutions?—Yes, and for the science work, which the manufacturers are very anxious to promote. The Keighly mechanics'

institution is entirely due to the exertions of the manufacturers of Keighley.

6148. You are endeavouring to establish a college of science in Yorkshire; will you be good enough to state what steps have been taken and what prospect you have of accomplishing your object?—The work which we have done up to the autumn of 1869 was of this character. We saw that we were creating a large number of science classes in Yorkshire—the ordinary science classes of the department—and that from those classes there would come a goodly proportion of the students who would require higher instruction. We had had brought before us by the engineers and by the woollen and worsted manufacturers the importance of having in Yorkshire a college where the sons of manufacturers might obtain that higher knowledge which they so much desired. Accordingly a meeting was held in Leeds convened by the Yorkshire Board of Education on the 5th of November 1869, presided over by Lord Frederick Cavendish, who is the President of the Yorkshire Board of Education, and at which a very large number of the leading men of the county were present. A committee was formed consisting of a number of gentlemen, the mayors of Yorkshire and the chairmen of the Yorkshire Chambers of Commerce and Agriculture. That committee appointed a sub-committee, who have already presented their preliminary report, which has been adopted, and the full report will be issued about Easter. The proposal is to establish a college of science, and to establish chairs for chemistry, mining, engineering, mathematics, natural philosophy, and geology. The students' fees will range from 20*l.* to 25*l.* per annum. No provision will be made for boarders, but arrangements will be made similar to those at King's College and at Owens College. The buildings to be erected will be so designed as to be capable of extension. The professorial chairs are to be endowed by sums not less than 350*l.* plus a proportion of the pupils' fees, and the committee propose in the first place (their proposal has not yet been accepted by the board) to establish chairs for chemistry, for engineering, and for mathematics, and to add to them other chairs as their resources enable them to do so. The estimate for the commencement of the college is 55,000*l.*, the full sum required is 100,000*l.*

6149. Has any application been made to the government for their aid?—We are not yet in a position to ask for aid from the Treasury. We could obtain the aid of the Science and Art Department, but that is so small that we should not accept the 500*l.* which is offered, fettered as it is with restrictions. Another point in connexion with it is the action taken by the Endowed Schools' Commissioners. We are carefully watching and in active co-operation with the commissioners with respect to the reorganization of schools, and in all the schools that are being reorganized provision is being made for the teaching of science. The Commissioners have also written to us to say that in any case where we can obtain the consent of trustees of endowments that are not directly applied to an endowed school, and can transfer them to the Commissioners, they will retransfer them as soon as the college of science is established in the form of endowments for professorial chairs or for scholarships. Moreover, in all schools where the endowments will permit of it, arrangements are being made for exhibitions for science to be competed for by the pupils of the schools, and to be held at some authorized place, the Universities or Owens College, and the Commissioners were good enough to say that they would make their schemes sufficiently broad so that exhibitions might be held at the college of science when established.

6150. Is there any further point in the operations of the Board of Union that you would desire to bring before the Commission?—I have one point to mention. We suggest the introduction of a lower standard or class into the examinations of the Department of Science and Art. We find, as in the case of Sheffield, to which I have directed your attention, that 25 passed



what we understand to be severe examinations; the examinations are of a high standard. Not that we want to lower the standard by any means, but we do feel that if we are to maintain our science classes we must have preliminary instruction given, and that we say should be given in the school, and there tested by examinations. We do not wish to institute examinations ourselves, but we wish that the Science and Art Department should provide for science as they do for art. And we are supported in that view by a paper which was handed in to Mr. Samuelson's Committee on Technical Education, by Captain Donnelly of the Science and Art Department. We also suggest the establishment of a sixth standard, which would be applicable to elementary schools, and a payment of 10s., or even a smaller sum, on the results. That is a point which we feel absolutely necessary for the promotion and extension and even for the maintenance of our science work.

6151. (*Mr. Samuelson.*) That would be a standard in substitution for the present sixth standard of the Department at Whitehall?—I am making a slight mistake. The Department of Science and Art alters its regulations so much that it is impossible almost to follow them. Formerly there were five stages in the Science and Art Department, now they are split up into the advanced and elementary. What we ask is not a sixth standard, but a lower standard, lower than the second class elementary standard of the Science and Art Department. That would be in point of fact a standard lower than the old fifth.

6152. (*Chairman.*) Would it not, perhaps, be better, than running the risk of lowering the standard, to require that any student passing in that lower standard should persevere to attain the higher standard, and that the teacher should then be paid for the instruction in both grades, rather than that he should be paid only for the instruction in the lowest grade?—But in drawing there is a small fee of 3s. per head paid for a very elementary amount of teaching, and all we ask is that there should be a recognition and an encouragement of the teaching of science of a more rudimentary character than that which is required now by the elementary stage of the science examinations.

6153. The obvious objection to that on the part of the department being no doubt that if that instruction ended there it would not be worth paying for, but if it proceeded to another stage, and was a necessary step towards this further stage, it might then be paid for?—Exactly so; that would meet our views in every way.

6154. (*Mr. Samuelson.*) Can you give the Commission any further particulars about the schoolmasters' science classes to which you have referred, as to their organization and the mode in which they are conducted?—Those schoolmasters' science classes were a tentative work. We undertook to provide ourselves with qualified teachers for the science classes we wished to establish, and instead of taking anybody and qualifying him as a science teacher, as has been done largely in Lancashire in the geometrical and machine drawing classes, where the workmen were taken out of the mills, we held strongly to the opinion that a man who had received his training at a normal school, and was by profession a teacher, was more qualified to impart instruction in the subject than those who were not professional teachers. Accordingly we restricted those classes entirely to the schoolmasters. We then engaged Mr. Jarman, almost our only science teacher at that time, and we placed him in charge of one class which was held at the parish church school of Leeds, and he provided a laboratory and we paid him a salary, not conditional upon the grant, but we undertook the salary. I cannot at the moment remember the amount, but at any rate we went upon this principle, that we must get the best man we could to teach the schoolmasters, and we must secure him against any loss through any cause whatever by reason of his pupils not passing the examination, and therefore we guaranteed him a certain sum; but so successful was his work that we were not called

upon for the guarantee, and he derived a larger sum than the guarantee amounted to. The schoolmasters also paid a fee of half a guinea; we charged them that fee of half a guinea, and an additional half guinea if they did not go into the examination. We thought it was only right to make those special arrangements.

6155. Then his success was in the shape of payment by the Department on results?—Yes; the amount that he got from the Department, plus the fees, was the payment which he received, we paying the expenses of the room and all the outlay for organizing the class.

6156. Are you aware whether those schoolmasters who were taught defrayed the fees themselves in the majority of cases, or whether they derived them from some extraneous source?—They paid them themselves.

6157. And did they come from any considerable distance?—Yes, at Leeds some came from a distance of 20 miles to attend the class. The places at which we have held science classes for schoolmasters are Leeds, Sheffield, Bradford, Halifax, Huddersfield, and Wakefield. We have not continued these classes simply because we have created the supply that we wanted, and now we say we are not called upon to continue special schoolmasters' science classes because we have ordinary science classes established, and those who did not avail themselves of the opportunity that we gave them must now get their instruction at those classes, although when we get the college of science established we shall again have science classes for schoolmasters, because one object that we have in view is specially to train science teachers.

6158. During how many years were those classes continued?—During the winter of 1868–9 and 1869–70.

6159. What were the subjects taught in those classes?—Chemistry, mathematics, plane and solid geometry, machine drawing, and building construction.

6160. Of all of which Mr. Jarman, I presume, was the teacher?—No. Mr. Jarman taught the Leeds class and the Halifax class, the subject being chemistry. We had to send to Lancashire for a teacher for the Huddersfield class in geometrical and machine drawing, and at Sheffield we had another teacher, Dr. Harrison.

6161. Did the teachers take more than one subject each?—No. Mr. Jarman's was confined to chemistry and Dr. Harrison's to chemistry, and Mr. Hick, B.A., and a Bachelor of Science of London University, taught mathematics at Leeds. Then we also established a science class for schoolmistresses in physical geography, which was a very great success, placing that under Mr. Ison, the master of St. Peter's School, Leeds. The result of this class is that physical geography is taught in two or three girls' schools.

6162. (*Chairman.*) Is more than one subject taught in each of those towns?—In Leeds there were chemistry and mathematics; in Huddersfield chemistry and machine drawing; in Bradford chemistry, magnetism, and electricity; and in Sheffield chemistry, machine drawing, and mathematics.

6163. (*Mr. Samuelson.*) With reference to the remuneration of the teachers of those classes, were they all sufficiently remunerated without any recourse to subscriptions?—No. In some cases we have had to pay the deficit. At Wakefield and at Sheffield we have had to pay the deficit. The classes were not sufficiently remunerative there, and we were obliged to give perhaps above the market value of the teaching, owing to circumstances.

6164. Was the deficiency paid by the Yorkshire Union or by local mechanics' institutes?—By the Yorkshire Board of Education.

6165. Have you also abandoned the classes for schoolmistresses?—Yes, we have given them up because our work is getting so very extensive that we have been obliged to abandon portions of it, and we have abandoned those portions that we think no longer need our support.

6166. You stated that the feeling is very strong in Yorkshire that the county does not receive back in support of scientific instruction a sufficient share of

H. H. Sales,  
Esq.

17 Feb. 1871.



H. H. Sales,  
Esq.  
17 Feb. 1871.

what it pays in the shape of taxes as compared with London; do you think that that feeling really causes local subscriptions to be withheld?—I am not prepared to say that; I know that it did operate in the case of the science lectures of which I have spoken. We found whilst acknowledging its importance, and desiring us to take up the subject of special scientific lectures, an unwillingness to contribute, inasmuch as similar lectures were given at the expense of the government in London.

6167. Has that feeling manifested itself in reference to the proposed Yorkshire college of science?—No; because in this matter we feel that this is really a manufacturers' question, and although we have got the offer of money we are not asking for money, it is fairly a matter of business. We first of all want the county to accept the scheme which the committee will put before it, and we do not want to ask for money till the scheme has been approved. So that we have not tested the feeling of the county to any extent, in fact what we have had offered has been voluntary.

6168. Do you expect that you will be able to carry out that scheme without State aid?—Certainly without State aid in the form that is now given by the Department of Science and Art, which would be too small for our purposes. We should be without the range of the operations of state aid from the Science and Art Department because the students will be of a superior class.

6169. Do you expect that you will be able to carry the scheme into operation without obtaining aid from the State?—We do, or else we shall not carry it out at all; there is no hope of getting much money from the State, I am afraid.

6170. Do you think that the payments as now made upon results by the Science and Art Department are upon a fair footing?—The present system of payment upon results is unsatisfactory, as it is determined by the attendance at the examinations only. I should like to read an extract from a letter from one of our teachers that we trained ourselves, who is engaged in teaching geometrical drawing, in which he says, "Let the Department make it worth a teacher's while to give a good elementary knowledge by paying for it by a capitation grant on attendance, or in some such way, and not leave the entire payment to depend on results of examination, it being well known that most labour and time is spent on those students (the backward and dull ones) who produce no results." He refers there to the point that there is an immense amount of labour devoted to those who really cannot come up to the standard, and that such labour is unrecognised by the government. We have found that the universal and I may say the unanimous complaint of the teachers is, that the payments upon results are not fair as being simply the results of examination, but that in some way it should include the results of attendance.

6171. Can you yourself suggest any way in which that could be carried out without really paying, as it were, in the wind?—Simply by paying upon the results of attendance, properly authenticated and surrounded by the necessary safeguards.

6172. What are the safeguards which you would propose?—I should say that there should be an inspection of the class in the same way as the primary schools have been inspected, and also in addition to that the signatures of the committees to the registers, kept in the same way as the Whitehall Department now require registers to be kept.

6173. What is your opinion of the present system of inspection of science schools?—I have no hesitation in saying that is a mere farce.

6174. Do you give that answer deliberately?—I do. An inspector comes, in many cases he knows nothing of the subject in which he is to inspect the class, he knows very little indeed about the organisation of the class, and at the close of the examination, when he meets the committee, and the committee ask him what advice he has to give them, and what suggestion he has to make, it is very seldom indeed that any suggestions of any kind are offered. The inspection of the science

schools is being totally different to the inspection of the schools under the Whitehall Department.

6175. Do you think that even as an inspection simply to ascertain that the conditions of the department are complied with, it is inefficient?—No, not in that respect inefficient, but the conditions require hardly any inspection to see that they are complied with.

6176. (*Chairman.*) Is that a result worth paying for?—No.

6177. Have you ever considered whether it would be possible to have a graduated inspection which should include the purely elementary science classes and evening schools, the more advanced science classes, and also the ordinary elementary schools which are now inspected by the Whitehall Department, so that by say three steps of examiners you would cover the whole field of inspection?—I have not thought of that scheme which you have now enunciated, but what always has appeared to me is, that the inspectors should be men qualified by professional training for their work. It has been the great defect of the inspection of primary schools, that the inspectors have had to learn their work by their visits to the schools which they were called on to inspect. We have in the case of one inspector of the Science and Art Department, a gentleman who is now acquainted with his work, but he, like others, has had to learn his work by his visits to the institutions in the same way, proving in my opinion, and I speak from experience in this matter, that an inspector should be qualified for the work which he is called upon to do. It is not merely whether a certain register is filled up right, but he should know when he enters a room whether the work is being properly done in that room.

6178. You are aware that an inspector at present is really an examiner of elementary work in an elementary school?—Yes.

6179. In like manner there might be an examiner of the work in an elementary evening school, might there not?—Yes.

6180. Taking the humblest classes of science schools, they would require, would they not, something like a similar examiner in science?—Yes.

6181. Taking the higher classes of science schools, they would require a much more competent examiner and inspector?—Yes.

6182. My question was directed to this, whether there might not be a graduation of inspectors, rising in qualification to discharge those several functions, their operations being co-ordinated so as to occasion a very considerable saving in expense, and to bring them under the control of one department?—Undoubtedly; when I said that the inspection of the science classes was a mere farce I meant that seeing that there are 28 subjects in the science list it is impossible that one gentleman can efficiently inspect in all those subjects, and consequently the inspection is a mere matter of routine, and an inspector who offers remarks in some subjects makes ludicrous mistakes which damage the result of his visit. His non-acquaintance with the circumstances and details of class-work renders his inspection of no value. The inspection should be either wholly limited to an inspection to see whether the official regulations are complied with, or it should be an inspection something of a similar kind to that which you have indicated, where the inspector is qualified to give an opinion respecting the teaching that is carried on. The inspector has to report whether the teaching is efficient, but he cannot report that in subjects with which he is utterly unacquainted.

6183. (*Professor Huxley.*) Did I understand you rightly with respect to one part of your evidence in which you suggest that there ought to be questions easier, as I understood you, than those which are set for the present pass in the elementary stage?—I did not suggest that the present remuneration should be given for an easier set of questions, but that there should be an easier set of questions with a smaller rate of remuneration, so as to lead up to the present standard.

6184. Have you ever had an opportunity of looking



over the answers which enable candidates simply to pass in the elementary stage?—Only a cursory glance at some of the papers at the local examination.

6185. Is it not really the case that they are let through very easily for a very small amount of anything that may be called information, and would not paying for a less amount be almost unjustifiable in your opinion?—I am not aware, and those of us who are promoting the scheme cannot tell what the standard is that the examiner sets up and allows the pupils to pass. I would say, in reply, that if the standard now is low I would pay a lower grant upon that low standard, and raise the standard for which the present grant is paid. If the standard at present is so low that the answers are very meagre and poor, then it is a waste of government money, and I was going to say it is a delusion, if you will pardon my using the expression, because we think that the candidates have really some appreciable amount of scientific knowledge.

6186. But are you aware of this practical difficulty which would arise, that the elementary stage of examination includes a considerable range; for example, a candidate may pass either in the first or in the second class; if he passes well in the first class the amount of knowledge which he may show may be such as to justify fully the payment at present made; but I will not deny that it may justify the payment at present made if he passes at the top of the second class. Then there is a slow and insensible gradation of badness until you get at those who simply slip through; and the examiner does not feel justified exactly in rejecting people whose amount of knowledge is really very small. Under these circumstances you could not have an exact sliding scale prepared to meet all those cases, you must roughly deal with it?—We have always opposed the lowering of the standard of the science department, and when the examination results became known this year, when the action of the Department was so disastrous in Lancashire and also in Yorkshire in subjects I., II., and III., the position that we took was this, that we thought the Science and Art Department were perfectly right in what they did, but we did not agree with the suddenness with which they did it, because it was the Science and Art Department that had set up the standard, and suddenly it raised its own standard, to the injury of the locality. We did not object to the raising of the standard, but we did object to the suddenness. Then, in reply to your question, we say that it would be better to have a low standard with a low payment, rather than that pupils of low attainments should be paid the higher payment, as at present.

6187. The sudden shifting of the standard only took place, did it, in three subjects?—Only in three subjects.

6188. Have you put before us all the papers relating to the organisation of the schools in Yorkshire, with all the details?—No, but if you will allow me I will hand in a condensed statement of the progress of scientific instruction in Yorkshire since 1867. (*The same was delivered in. Vide Appendix XI.*)

6189. Are you satisfied with the operation of the present science scheme, and are the better class of teachers in Yorkshire particularly satisfied with the working of the science scheme as it is at present applied?—I should not like to answer the latter part of the question, for this reason. Neither myself nor anyone connected with the management of the Yorkshire Board of Education or the Yorkshire Union of Mechanics' Institutes derives the slightest pecuniary benefit from the action of the department, and consequently we look at that action more impartially than those do who are benefited by it, and therefore if you will allow me I would rather not answer anything with respect to the teachers.

6190. Can you say what influence the system at present pursued by the Department of Science and Art has in encouraging good teachers and discouraging bad ones?—The action of the Department has been this: it appears to have started with the endeavour to promote the extension of science classes throughout the country, and in doing so it has adopted certain lines of policy which probably the originators would

not now adopt if they had their experience over again; and the result of the scheme has been that the teaching has not been sound, and that there has been a great deal of cram; but on the other hand, I would say that year by year the system of the Science and Art Department is becoming more and more adapted to the requirements of the country, and more and more fitted for the sound and healthy inculcation of scientific teaching.

6191. Are you aware that in any part of Yorkshire dissatisfaction with the results of the science examinations exists to such an extent as to prevent the best class of teachers from connecting themselves with the Science and Art Department?—No, I am not aware of such dissatisfaction, nor does such exist, inasmuch as there is a constant increase of University graduates who apply for the honorary certificate of the Science and Art Department.

6192. Do you think that the present system of examinations by the Science and Art Department has a tendency to encourage book work, and to discourage the careful training of the students in actual practical work and observation?—It certainly did so; but the recent minutes of the department go in an opposite direction, and very beneficially so.

6193. Do you think that the amount of change which has been made is sufficient, or do you not think that a greater step might be made in the same direction with advantage, by some such process as this: to give in some of the science schools a course of instruction lasting over two years, taking the examinations at the end of two years in classified and selected subjects: as, for example, supposing that you take in the first year, we will say, elementary physical geography and elementary physics, and suppose that you take in the second year's examination chemistry and elementary physiology, and then suppose that you proposed to make your instruction in those four subjects, and those four only, as complete and thorough as it could be, and take your examinations upon the continued course of instruction, would that, or would it not, in your judgment, be a better method than that which is at present pursued, of allowing a student to take up anything that he likes?—The course that you have indicated is one which I have always advocated as being the only mode of giving real scientific education to the working classes. I think that in our institutions for the scientific education of adults the course of study should be prescribed by authority in three or more subjects, and that there should be an examination requiring the student to pass in a certain number of the selected subjects, as is required in the University local examinations.

6194. Do you think that by the general adoption of properly organised schools of that kind a great many evils in the way of cramming which are now complained of might be entirely got rid of, and the instruction be made consecutive and organised?—Yes, certainly. I have mentioned the proposal to the central committee of the Yorkshire Union as a subject we should as far as we can enforce upon the notice of the associated institutes, that the managers should not allow pupils to select a particular class, but that the managers should say, we know what are the subjects necessary for you to be instructed in, and you must take up a certain number of those subjects.

6195. But supposing that your pressure of other work became lessened, are there any practical difficulties, do you think, in the way of establishing schools of that kind throughout the length and breadth of Yorkshire?—This work of which I am now speaking would not require the establishment of new schools. It would be simply the regulation of the Science and Art Department, which regulation they seem tending to in this year's syllabus, by grouping together subjects for examination. Now if the Science and Art Department were to make a regulation that certain groups of subjects must be taken, that would meet the necessities of the case, and then, instead of having a chemistry class only in an institution, we should have the other classes that were necessary.

6196. I do not quite clearly understand what kinds

H. H. Sales,  
Esq.

17 Feb. 1871.



H. H. Sales,  
Esq.

17 Feb. 1871.

of science you have taught to young people in the primary schools ranging between the ages of 10 and 15. Do you follow there a prescribed course, or do you give the same kind of scientific information to children of all ages?—We consider that the children in attendance at the primary schools who would attend at lectures of the same kind as those that we established at Sheffield would be about the same age and about the same intellectual standard. At Sheffield we made this condition, that every child who was admitted to the class must have passed the fourth standard of the Revised Code, that we might be sure they had got some amount of elementary knowledge. I very strongly advocated a class in physical geography at Wakefield, much against the wishes of the local committee. They said that physical geography was a subject in which there could be a great deal of cramming. I did not think so, but my experience is against my previous opinion. At Wakefield the class was a complete failure, not from the organisation, which was similar to that at Sheffield, but simply that it was a cram.

6197. That surely did not arise from the nature of physical geography itself, but rather from the bad standard to which the young students of physical geography were made to work?—Exactly so.

6198. You found, did you, that children of 10 years of age were quite capable of taking in instruction in physical science?—In the rudiments of physical science, of course it was the very rudiments.

6199. (*Dr. Sharpey.*) What is the constitution of the Yorkshire Board of Education?—There are two societies, the Yorkshire Board of Education and the Yorkshire Union of Mechanics' Institutes. The Yorkshire Board of Education is a voluntary association, consisting of a large number of gentlemen resident in the county. Lord Frederick Cavendish is the president of the board, and it is a purely voluntary organisation. The Yorkshire Union of Mechanics' Institutes, founded in 1837 by Mr. Baines, M.P., and of which he is president, is an association of institutions paying a certain fee per annum, according to their size, gentlemen in the county also subscribing towards the expenditure.

6200. Does the Board of Education raise any funds?—Yes, the income of the Board of Education is about 300*l.* a year for carrying on the work.

6201. With regard to the proposed college of science in Yorkshire, you contemplate that one function of that college will be to train teachers in science; would that imply the maintenance of the teachers when they were studying, or simply the giving to them an opportunity of instruction?—An opportunity for instruction would be the first thing; but we hope by the establishment of scholarships and exhibitions to provide for the case of those students who could not otherwise avail themselves of the advantages of the college.

6202. Supposing there were an institution in London for the training of teachers in science, and that you had organised a new college in Yorkshire, and were prepared there to give such instruction, what would you think would be the relative advantage or disadvantage of the opportunities in the one case and in the other, there?—The point has not come before us with respect to the relative advantage of a training school in London versus a training school in the provinces. The fact is that there is no such training school in existence, and we feel the need of such a school, and that the teachers should be under professors of the greatest eminence who could be secured for the work. That is one reason for attaching the training of teachers to our college scheme. Another is, that we have now, we may say, trained a number of certificated teachers, and qualified them to take a science certificate, who are now qualified to teach science. We have done this with the very limited means at our disposal, and those means will be considerably extended when we have a large institution thoroughly organized, and eminent men at the head of that institution giving instruction. Those teachers will not come to London to receive instruc-

tion. There is a new minute out requiring them to undergo examination prior to their attendance at lectures in London, but they are very much opposed to the action of the Science and Art Department; in fact I may say this, that the action of the Science and Art Department is of that constantly shifting kind that it has lost the confidence of the teachers throughout the country.

6203. Supposing that you had a well-organised college of science, with eminent and capable teachers, and were prepared to give that instruction to the teachers which should fit them for their duties, do you think it would be reasonable to insist upon the teachers in Yorkshire coming up to London to get their training in London?—No, I think not. I think it would be unfair, because the teachers whom we should have for the ordinary rudimentary science schools, where they would teach only the elements of science, such as are now taught in our science classes, are engaged in tuition at the present time, and they could not afford to come up to London for a month or six weeks, as is now the regulation of the Science and Art Department, but they could afford to give one or two nights weekly to go 12 or 15 miles per night, and they would do so and would avail themselves of the advantages if they were placed within their reach. It is nothing to say what is the number now coming to London, that only points to this fact, that of the science teachers there are a large number who go at very great inconvenience and expense to increase their knowledge, and how much more would that number be increased if the means of obtaining the knowledge were in the immediate locality.

6204. And how much more would the contrast tell, supposing they were required to spend a whole year or nine months out of the 12 months in London?—There are no persons who are now engaged in teaching who would be able to come to London for that time, they could not possibly afford to do it.

6205. Supposing it were offered to maintain them in London at a certain stipend while they were here, say that 50*l.* a year were assigned for their maintenance, do you think that that would attract teachers from your district to London?—Certainly not those who are in present employment; it might attract the young teachers who were coming out of a training school, but then the training schools should, we maintain, also have their laboratories, as they have at Battersea, at Chester, and other places, and all the teaching that that class of teachers require should be got at the training schools. I am now speaking of the class that we get for the primary schools who are those who are teaching science classes in Yorkshire.

6206. But those could get further instruction, could they not, in an establishment such as is contemplated in Yorkshire?—Most decidedly, and a higher kind of instruction altogether. We find that a teacher who has obtained a certain amount of scientific instruction in a normal school, when he comes from that normal school desires to carry on that instruction, but now he can only do that by coming up at great inconvenience to London. In Manchester they can do it at Owens College, but we propose in Yorkshire to do the same for the constant stream of teachers that are coming into the locality who have already been in the training schools, and those teachers whom we have had in the schoolmasters' science classes of which I have spoken. Whilst we have a number of men over 35 years of age, the great majority of the schoolmasters who are trained are young men from 21 to 30.

6207. From what you know of the feeling in the country generally, in reference to this question, I suppose that besides such a college in Yorkshire and besides Owens College, in other great populous and rich districts there would also be similar colleges established, say in Newcastle, or Liverpool, or Bristol?—Yes; a movement is on foot to extend the operations of the Durham University to make it a college for the engineering districts of the north, and the Dean of Durham has been in communication with me to see how far the operations of the University can be extended into Yorkshire. But, so far as I can see,



the operations of Durham University will not extend further south than Middlesbro' and Stockton, because there intervenes a great agricultural district between it and the manufacturing district of the West Riding, whose interests are to a great extent different; and the local circumstances are such that the inhabitants would not avail themselves so much of an institution at Durham as they would of an institution at Leeds or Sheffield.

6208. So that there would be in different great centres in the country institutions of that kind for education, and what we may call the highest education that could be got, in which science teachers could be adequately trained?—Yes, and conveniently trained.

6209. And with much greater facility than having to travel to the metropolis and stay here?—Yes. Another great advantage of the local training of teachers is this, that they are in the midst of the district where the work for which they are being trained is carried on, which is not the case in London.

6210. And, therefore, as to the question of economy, I presume you would consider it a much more economical arrangement that they should receive their instruction in those localities, than that a college or institution large enough to teach all the teachers throughout the country should be established in London?—The establishment of a central institution in London would, in my opinion, be a great mistake, but I think that there should be general colleges established similar to the one which we are proposing for Yorkshire, where one of the special objects in the establishment of the college is the training of teachers; and it is much better, in my opinion, that these colleges should be established in the localities, provided that they are on a sufficiently large scale to secure the services of eminent professors, rather than concentrating them in London.

6211. With regard to the kind of instruction that is called training which would be given there, it would be, in the first place, would it not, the communication of the actual knowledge of the science which it was expected that the teacher would give instruction in, and that that should be given in a thorough way, and that the teacher should be acquainted with it not merely as book work and mere lecture work, but practically as far as it was capable of being taught practically?—Exactly.

6212. But in addition to that, what is your view as to any special preparation or training in the art of teaching for untrained teachers?—Untrained teachers, most assuredly, must have instruction in method, because the fact before us is this, that some of our best scientific men are the very worst to put before an audience to instruct them; and what holds good with respect to them also holds good with respect to those who are inferior to them in ability, and it is no use imparting knowledge to a teacher unless he also is trained to impart it to others.

6213. Can anything be done in that way by example; for instance, supposing there were a school in which science was taught in the best way by accomplished teachers, would not that be a means of instructing other teachers (supposing always that they had the information) as to the mode of communicating it?—That would be one of the duties of the master of method who might be in connexion with the local college of science. His duty would be to exhibit the mode of teaching a class, and practising the teachers in the art of teaching, exactly in the same way as teachers are trained at the normal schools at the present time. It is not so much the amount of knowledge that they can communicate to the class, but the way in which they communicate it, that is criticised, by the master of method. He also gives lessons to show the way in which the class should be managed.

6214. Do you think that any considerable amount of public money would be required to be devoted to the establishment and the carrying on of such institutions as you are now speaking of in the country?—Not a large amount of public money would be required, but more liberal treatment than at present we receive from the hands of the government.

6215. The rest would be done, I presume, by local exertion, and by the fees of the paying pupils?—Yes.

6216. With regard to mechanics' institutions and local institutions, are there any well provided with natural history museums, geological museums, and zoological collections of any extent?—There are none in Yorkshire so provided. We have an excellent museum available to all classes (the admission only being a penny) at Leeds, in connexion with our Philosophical Society there. It is one of the best museums in the provinces, that at Leeds; but in connexion with the mechanics' institutions we have no such museums, simply because the small amount of pecuniary aid that they receive does not permit them to establish museums.

6217. But are there local museums in various parts of the country, though not connected with mechanics' institutions?—Yes.

6218. Are you disposed to attach much value to those collections as a means of learning?—Not as they at present exist. A museum to be of service should be used by competent professors taking the students into the museum and explaining to them the contents thereof; otherwise the geological museum will be passed through without notice, whilst a mummy of something from the South Seas will be the part which will occupy the attention of the audience. The reason why in my opinion the working classes do not go to museums is because there is no person there to explain to them what they see; and a museum is only valuable to the general public when classes are established in connexion with the museum, and the professor takes his students to the museum and enlarges upon the lesson by examples which he cannot take into the lecture room.

6219. (*Chairman.*) When a young man has come from a training college into the country, and is settled in a school with an average salary of 90*l.* a year, which probably in a few years will rise to something like 120*l.* as an average, is there much prospect that he would leave his school and go to London to spend one or two years in learning science in the training college in London, with a view to taking another position, unless he had some peculiar and overmastering impulse towards science, or would he do it with much prospect of bettering his condition?—I can only give my own opinion in the matter. I think that such an idea is perfectly illusory; of course you may have here and there one who may do it, but that is only exceptional. Instead of having any large number, my own experience would lead me to think that you would have but very few indeed who would do so. You must take this into consideration, that they leave the training college and go to the country for a year or two; they begin to form connexions and associations in the country, and it must be some overpowering desire for scientific knowledge, and of bettering their position in life through getting it, that would lead them to do so. I do not think that any training school would receive a large number of pupils of that kind.

6220. Looking to the opportunities which at present exist in the country for the employment of very highly instructed scientific teachers of that class of life, are there many institutions that could provide as high a remuneration as 120*l.* a year for a young man, however highly instructed in science he might be?—Such positions would be rare.

6221. You have said that at Battersea there is a chemical laboratory. You are probably aware that it is the intention of other of the more prominent training colleges, for example, St. Mark's, to cultivate very actively the study of science, and to connect with those institutions laboratories?—Yes, I am aware that that is the case.

6222. Do you not think it very probable that if any encouragement were given to the introduction of scientific instruction, either into elementary schools, or into superior classes connected with elementary schools, almost every training college in Great Britain would establish a laboratory as a means for scientific instruction?—I read a paper before the Society of Arts

H. H. Sales,  
Esq.

17 Feb. 1871.



H. H. Sales,  
Esq.  
17 Feb. 1871.

on the 3rd of March 1869, bearing upon that subject. The paper was "On the adaptation and extension of 'present means for scientific instruction;'" and after treating upon what should be done in elementary schools I say, "Next in order of advancement is the 'provision that it is necessary should be made for the 'special education in science required by the embryo 'manufacturers and managers of factories.'" I then advocate the establishment of colleges of science, and I go on to say, "In the meantime there is a class of 'educational institutes that may be utilised as central 'colleges, and with regard to which only sentiment 'and not vested interests can be opposed to their 'transformation. Scattered throughout the country 'are normal schools or training colleges for school-'masters." I then refer to some remarks that were made by the principals of training colleges. I go on to advocate the utilisation of those training colleges without ignoring their special functions. I show the number of students for whom accommodation is provided, and the number of students resident at such a date, and I show that while, for instance, at Peterborough, there was provision for the accommodation of 46 students, there were only 29 at that date there; and I say that the difference between 29 and 46 could be made up by teachers specially being trained to go out as science teachers. Not that they should wholly devote their time to science teaching, but that they should have as a part of the work of an elementary school the introduction of science into the school.

6223. You are probably aware that owing to the present demand, the training colleges are rapidly filling, and that they must in a short time be quite full of students?—Yes. This paper was read before the Education Bill, the operation of which will, I anticipate, fill them.

6224. And you are aware likewise of the improvement of the curricula of study, to which I have already adverted?—Yes, certainly.

6225. Have you any apprehension whatever that that improvement in the curricula of study will be generally adopted in the training colleges?—So far as the public is concerned, by which I mean everybody outside the government, such extended study would be promoted; but after our experience of the Revised Code I scarcely know what to say. The teachers were then receiving a very fair instruction in the elements of science, but we were told that we were training schoolmasters as razors to cut grindstones. I remember well that that was the expression which Mr. Lowe used, and the consequence was that the curricula of the training college was cut down and science was entirely eliminated, and now we are getting back to where we were before 1862.

6226. You have no doubt that the operation of the Education Act and the great growth of public opinion upon those subjects will correct the evils which were brought about by the Revised Code?—They will.

6227. If that were the case, even if students spent only two years in a training college, they would come out with some knowledge of the elements of certain parts of the sciences?—Certainly, because the best science teachers that we have in the country now are men who obtained their education principally at the training colleges, when science formed an important part of the curricula.

6228. A youth who is trained according to the method adopted for elementary schools has first an experience of five years, during his apprenticeship, in the actual practice of teaching; he has then two years in a training college, where the principles of teaching and the practice of method are carefully inculcated. And if to these be added instruction in the elements of science, you would expect from him much greater efficiency than if he were taught only the science without the method?—Certainly.

6229. If, for example, a teacher were needed for higher scientific instruction, and a third year of training in a college were provided by the government, with sufficient inducements for further scientific instruction, you would expect that a young man having passed through that apprenticeship, and having passed through three such years of training in the College, would be remarkably skilful in the communication of science?—Certainly.

6230. You could not expect that a college which simply gave instruction in science itself, without giving instruction in method, would generally produce successful teachers?—Not unless there was a natural ability in the teacher, which would have to be developed by the experience which the teacher got. Instruction at a college of science could not without a method department produce science teachers.

6231. Do you think it is very likely, in the present state of the demand for science teaching, that pupil teachers, at the end of their apprenticeship, would be likely to be diverted from the career offered to them in the training colleges to such a college of science in London?—No. Pupil teachers now, to a very great extent, are pupils in science classes, and they will, we expect, at the end of their apprenticeship be able to pass the examination in honours of the Science and Art Department, that is, assuming that the standard is not raised, but remains as it is at present. Then if the training colleges provided for further instruction in science, they would certainly, for a large number of years, go from their course of pupil teachership to the existing normal colleges, with the view of becoming primary schoolmasters, with the power of teaching science, rather than go to the science college, wherever it may be situated, with the hope of getting some higher remuneration from taking that course of action. Of course in this case there would be exceptions, and some would be diverted, yet the great majority would assuredly go on to the normal college, and from thence to the masterships of schools.

6232. But no great supply of students at such a purely scientific normal college would, in the present demand for instruction in science, be likely to be derived from the ranks of pupil teachers?—No.

6233. You are aware that there are assistants in certain of the humbler science classes which exist in the country now, and in East Lancashire we have called them candidate teachers, they being equivalent to the pupil teachers in the day schools. What do you think of the probability of any of those candidate teachers coming up to the normal school in London for instruction in science?—I have no experience with respect to that further than information derived from the East Lancashire Union by conversation with the officers. Having no personal experience, therefore, I could not reply more definitely than this, that I have no doubt that it is necessary that our science teachers should have science pupil teachers recognised by the government in the same way as the pupil teachers in the primary schools. That is a point upon which I feel very strongly indeed; but what the result with respect to the point upon which you question me would be I cannot say, because I have not a personal knowledge of the work.

6234. Of this you are quite confident, that a science college which gave simply instruction in science, even with the superaddition of laboratory instruction, would in the main fail to produce efficient science teachers, unless there were connected with it a school of method, and the means of practising the students in the actual teaching of science in classes?—I have no hesitation whatever in answering that question in the affirmative.

6235. Is there anything else which you would like to communicate to the Commission?—I am not aware of anything further.

The witness withdrew.

Adjourned.



6, Old Palace Yard, Westminster, Thursday, 9th March 1871.

PRESENT :

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, BART., IN THE CHAIR.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., LL.D., Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

LOUIS C. MIALl, Esq., examined.

6236. (*Chairman.*) You are a member of the Bradford Philosophical Society, are you not?—Yes, I am the secretary.

6237. And you have for five years past been engaged in the organisation of science classes?—Yes; a little more than five years now.

6238. In what district have those science classes been formed?—In the town of Bradford.

6239. You have yourself, I believe, conducted some classes. Will you state how many and in what subjects?—I cannot say the precise number now, but when I sent in my paper to the Commissioners the number was 18. I suppose I have conducted something like 12 or 13 since that. The subjects are geology, natural history (that is, botany and zoology), and occasionally some other subjects, such as human physiology, and during the last winter I have conducted classes on the distribution of plants and animals.

6240. You have likewise acted as local secretary for a science class under the Science and Art Department?—Yes.

6241. Having been in frequent communication with science teachers and pupils, and having had an opportunity of ascertaining what their opinions are as to the efficiency of the existing science schools, will you give us the result of your observation and inquiry?—I believe that the Science and Art Department is doing a certain amount of good in our neighbourhood as well as elsewhere. I think, however, it is not working so well in our neighbourhood as it is doing in other parts of the country. I have a number of somewhat serious faults to find with the system as at present carried out. The great objection, in my opinion, is that the regulations of the department do not encourage what I should call a real style of teaching; that the teaching of scientific subjects, which ought, as I imagine, to be of a highly practical character, is very largely conducted by such means as reading out slowly notes to be taken down verbatim, and committed to memory; or, again, by a large use of elementary text books which are made as condensed as possible, and are in some cases almost learnt off by heart by frequent repetition. I think there is a considerable deficiency of anything like good practical teaching. I think those imperfections largely arise from the regulations themselves.

6242. Have you any observations to make on the syllabus and examination papers?—I think in almost all the subjects which are included in the syllabus the range is too great. The subjects are too extensive, I think, almost without exception. The pupils who receive instruction in the science schools are mostly artisans, and have not had many previous opportunities of education, and therefore their capacity of receiving fresh knowledge is more limited than would be the case if they had had a good school course. I think in almost all subjects the course is too extensive both for the teacher and for the students. That objection applies with much greater force to some of the courses than to others.

6243. As to the questions which are put, have you any observations to make?—The questions that are set are of too difficult a character, but that objection, however, does not apply with so much force to the questions put at the last examination as to those of some previous years. I think, for example, that an examination of the questions put in May 1868 would show that they were far too difficult and quite above the ordinary

classes of students. In 1869 they were somewhat easier, and there is less fault to find with the questions put in May 1870. Still, however, I think there is considerable room for improvement in that direction.

6244. Does the examination in the departments with which you are best acquainted include any test as to the students' practical knowledge either of manipulation or of specimens illustrating the departments of natural science or of the power to describe them?—There is some such provision. In the subject of chemistry, for example, pains have been taken of late to make the examination as practical as a written examination can be, and a number of questions have been put, intended expressly to ascertain whether the students have been practically acquainted with the properties of the various substances which have been described; and I am told that there is a new regulation which was issued, I think, in December of last year which is calculated to make the chemical course still more practical, but I do not think that any examination entirely conducted by written papers can be a fair practical test. With respect to other subjects I think that in geology, mineralogy, and also in botany and zoology, specimens are exhibited which the candidate is expected to describe, and that of course is of considerable value. But I think that the practical part of the examinations is very defective and incomplete.

6245. As respects your knowledge of what the teachers themselves do in the way of illustration of their instruction in subjects of natural science, are you aware whether they avail themselves of any museums, specimens, or natural objects in the neighbourhood?—The practice of teachers in that respect is very various. Some of the best teachers make a great point of practical illustration. One of the best science teachers in connexion with the department in Yorkshire, pays considerable attention to those practical illustrations. Others of them are almost entirely indifferent to it, and some teachers who have passed a large number of pupils care little or nothing for any form of apparatus, or any visible objects. In one case I remember that a schoolmaster in the neighbourhood of the town in which I live, to whom I have frequently represented the necessity of making his teaching more practical, complained of the impossibility of getting suitable apparatus, and I offered to assist him partly by finding him some chemical apparatus of a simple kind, and partly by supplying him with a number of ores and metals, and various substances, which I thought would illustrate his course of instruction, but he declined to use them, on the ground that he thought he could pass his pupils better, and get better results if he left the practical part alone.

6246. With respect to the two objects of teaching, first the training of the intelligence, and secondly the communication of real knowledge, do you think that those modes of teaching are effectual?—I do not think that any such teaching is worth consideration at all.

6247. Have you any suggestions to make as to the minimum number of marks by which a student is enabled to pass?—The remark which is contained in my paper refers to regulations which have since been modified. I do not exactly know what the regulations are now with respect to the minimum of marks. I believe there is no published statement in the Science

L. C. Miall,  
Esq.

9 March 1871.



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9 March 1871.

Directory, at least I am not acquainted with any published statement as to the minimum of marks which will pass a student. A year or two ago the minimum of marks was extremely low: that is to say, a student might pass in a low class. It has been as low as 35 per cent., but without respect to the precise number of marks which will pass a student (I have no precise knowledge of that under the existing regulations), I think that students are often passed whose knowledge is, I might say, absurdly inadequate—students who have no real knowledge of the subject at all; and this is particularly unfortunate, as the passing of the examination qualifies them to become teachers. I am acquainted with one teacher in our town who is qualified to teach zoology. He attended last summer a course of zoology which I conducted, in which I made a great point of practical illustration. At the end of the course he told me that though he had been qualified to teach zoology for a couple of years past, the first real knowledge of the subject that he had was derived from that course of instruction, that up to that time he had no knowledge that was worth anything. He had not been taught, that is to say, he had had no master—he had got it up from books, but was entirely ignorant of every kind of specimen. I do not suppose he had examined with care a single specimen in zoology at the time that he passed his examination.

6248. But a teacher may obtain a certificate authorising him to conduct a science class who may not have had any such intelligent illustration as that which you have given in your own class, but may have passed in the other classes which you have described?—Yes.

6249. Have you any remark to make upon the text books which are ordinarily used in the science classes?—I consider the text books which are recommended in the Science Directory to be for the most part excellent manuals, but these are of course not insisted upon; they are not prescribed text books, they are only suggested, and in many classes other text books are substituted. Some of those are, I consider, of a very inferior kind. There are two mentioned in my paper. One is Cooke's "Manual of Structural Botany," that is a little book which has had, I believe, very great success. It has been largely in use in the botany classes connected with the department. I do not think it would be possible to frame a text book of botany which should be so signally deficient in useful qualities. It is almost entirely occupied with definitions of technical terms, but the important questions of vegetable physiology, all questions, for example, connected with the nutrition and the respiration of plants, are discussed in the most meagre and unsatisfactory fashion. With respect to the other book which I mentioned in my précis, Buckmaster's "Manual of Inorganic Chemistry," if I had been informed at the time I sent in my paper, of the present state of that text book I should not have referred to it. I find that it has been re-written, and altered to a very great extent by Mr. Jarman, and it is now, as I consider, a satisfactory text book. In some points it is superior to the ordinary text books, and on the whole it is a good text book, so that I should wish to withdraw Buckmaster's "Manual of Inorganic Chemistry" as an illustration of defective text books on account of the important alterations which have been made in it in the last year or two.

6250. What is the general testimony of science teachers as to their prospect of passing their students by the one mode of teaching as contrasted with the other?—I think I might say that almost every science teacher that I have spoken to on the subject, or a very large proportion of them, would say that if they looked merely to the securing of a large payment, they would not give that kind of teaching which they consider to be best. They would work largely by dictation, and endeavour to familiarise their students with certain formal statements carefully prepared beforehand, definitions, for example, and they would get them up so that a student could hardly make a mistake; and they would neglect the practical part of it, I think, if they were

not restrained by other considerations. Happily there is a sense of honour amongst the teachers, and they have a real desire to communicate knowledge, which in many cases restrains them, but if it were not for that, I think they would as a class go in almost entirely for what I call cram, as thereby they would be more likely to earn a large payment.

6251. According to their idea cram pays better than intelligent teaching?—Yes, almost all the teachers that I am acquainted with have told me something to that effect.

2652. What is your opinion as to examinations conducted by written papers as tests of merit?—I do not see that it would be possible, however artfully the questions were framed, to conduct an examination by written papers, in such a subject as chemistry, for example, which should be satisfactory, and which should discriminate between those students who had been well taught and those who had been carelessly taught. I think that all our written scientific examinations (for this does not apply only to the examinations of the Science and Art Department) at the London University, for example, are exceedingly defective. I have known instances in which young men have passed who were, I might almost say, disgracefully ignorant of the subject—and other instances in which young men who have had a fair sound practical knowledge have failed, and have had no opportunity of showing what they really knew. I can, if the Commission think proper, give examples of both kinds. I remember an instance which was in connexion with the examinations of the London University for the bachelor of science degree. I knew a young man who passed the first Bachelor of Science examination, which includes amongst other subjects zoology. He was passed in zoology, and he passed the examination altogether. Shortly afterwards he was looking round our small museum, and talking with me about some of the specimens which I showed him, and seeing a specimen of a cuttlefish in a glass jar, he asked me whether it was a sea anemone. That such a young man could have recently been passed in an examination in zoology by Professor Huxley and another examiner, must have tended to show that an examination entirely conducted by written papers cannot be so framed as to exclude candidates who are really grossly ignorant. Mr. Severs, who is a science teacher in Bradford, tells me that he has great reason to complain that some of his best pupils who are practically acquainted with the subject, are thrown out at the examinations on account of their inferiority to other persons, such as schoolmasters, for instance, in what might be called literary merit. They do not always frame their answers in a very neat manner; possibly their spelling is defective, and on that account they sometimes come out very poorly. He tells me that at the examination held last May in magnetism and electricity he had two pupils whom he considered to be well acquainted with the subject, at any rate with the elements of the subject. One of them had a good deal of apparatus in his own possession, and was capable of making his own apparatus, and understood a good deal practically about electrical apparatus. He is also a clerk in the telegraph office, and accustomed to work telegraphs, and his master considered that he had also a knowledge of the principles of electricity, but he was beaten hollow in the examination by another man who was a schoolmaster, but had no sort of practical knowledge, and possessed no fragment of apparatus himself, and was not considered by the master to have so good a knowledge of the subject; and I am told that similar instances of that character might be collected in great numbers from various science masters.

6253. Your deduction from that would probably be that there should be some opportunity of proving a practical knowledge of the subject by persons who have applied themselves to attain it?—I am afraid that is indispensable. Of course it is a very troublesome and expensive method; but I think that unless a practical examination is made a part of the annual examination,



the system cannot be expected to produce any permanent benefits.

6254. That would re-act very much upon the teaching, would it not?—Yes, undoubtedly.

6255. And would at once exclude a large number of teachers who are at present quite unqualified to give such instruction?—It would exclude them, unless they took pains to adapt their teaching to the new regulations.

6256. Can you state whether any well-qualified and successful teachers have had conscientious objections to work under the Department?—We have a number of science classes in connexion with our Philosophical Society in Bradford, and the question has been discussed more than once as to whether we should add to those classes certain others in connexion with the Science and Art Department, and get our present teachers to conduct them, but we find that the teachers themselves remonstrate very strongly. Our teacher of chemistry, for example, who is a well-qualified man, a good practical chemist, and a doctor of philosophy at the University of Giessen, I think, would find no difficulty in getting a certificate from the Department to conduct a class and receive payment by results, but he positively refuses to have anything to do with a class conducted in connexion with the Science and Art Department. He says that his teaching would in that case be necessarily, as he would consider it, so imperfect and so inadequate that he would have to confine himself to book work and to black-board work, and leave out the experimental part of his course, or pay much less attention to it, and he has refused to have anything to do with it. I may mention, although I ought hardly to call myself a successful teacher, and I am not qualified to earn payments, that I have myself refused repeatedly to conduct classes in connexion with the Department on that ground.

6257. You could not condescend to those arts by which a greater number of students could be passed than by that form of teaching which would ensure good mental training and impart sound knowledge?—The teaching which I am accustomed to give would not pass pupils. I know that from the fact that though our classes are not in connexion with the Department, a number of our pupils do from time to time present themselves for examination. We endeavour, as far as possible, to make all our teaching practical. In the geological classes we have access to a good sized museum, containing a number of valuable fossils, and those are used freely in illustrating the work of the class. Also during the summer we have a series of excursions (last summer we had 12 or 13), and the surrounding country is examined. Again, with physiology, the teacher of our physiological class is a surgeon—he is a hospital surgeon, and can provide himself with any number of fresh specimens. The class examine dissected specimens, and the microscope is constantly on the table. So with our other classes, practical teaching is made an essential part of the instruction. In our botanical class half of each lesson is taken up with the demonstration of plants, and there are frequent excursions; but our teaching does not qualify students to pass the examination of the Science and Art Department. They can pass with our teaching the elementary stage, but they hardly ever succeed in struggling through the advanced examination. They do not get up that style of answers that would suffice to pass them. We endeavour to make our class of instruction sound and practical, but we should have to adopt a totally different system if we aimed at passing a number of pupils. We should have to give up a very large part of that work, and go in for something quite different.

6258. (*Professor Huxley.*) Do I clearly understand you that the students taught in the way you suggest could not pass in the advanced examination in physiology under the Department of Science and Art?—With respect to physiological subjects, I think the only pupils sent up for examination were four sent up in May 1870. Of those four two passed, but certainly

the best of the four was plucked. I could speak with great confidence as to his qualification, he was decidedly the best of the four. One of the two who passed was a schoolmaster. A schoolmaster always has an immense advantage in having a little experience in passing examinations, and knowing how to frame his answers suitably, and in this case he got through. I do not think he was a very satisfactory example, and I would not put him forward as a specimen of our teaching. He is one of those who passed, but the other three, one who passed, and the two who did not pass, I think had a very fair practical knowledge of elementary physiology.

6259. In my examination my assistant examiners examine all the papers, and they mark their estimate of the passing or the number, as the case may be, attached to the questions. Whenever a candidate is rejected by them they have directions to mark the precise questions upon which he is rejected, and I always read those questions and answers myself, and satisfy myself that the man is rightly rejected before he is rejected, so that I think in those cases you may take my word for it that there was some very good reason for the men not passing, whatever might be their merits otherwise?—I am quite ready to admit that their knowledge must have been defective on some points, but the point to which my evidence leads is rather this, that we might with less pains have made sure of their examination had we taken up another system.

6260. I presume that you put your students eventually through the same extent of physiological knowledge that may be found in my Lessons, for example?—Yes, our course was not expressly intended for the Department's examination, therefore there was no pains taken to cover the whole extent of the subject, and I believe that some subjects which were included in your syllabus, were not treated in our course. For example, in that very examination there was a question respecting the vaso-motor nerves which had not been touched upon in our course.

6261. Your are probably aware that in the syllabus which the Department issues every year, the precise subjects are stated with great fulness?—Yes; it was stated in the syllabus that such and such were to be the subjects of examination.

6262. Therefore, it does not affect the responsibility of the examiner, if the students will not learn that which it is stated that they must?—No.

6263. (*Mr. Samuelson.*) I presume that what you wish to bring before the Commission is that if your pupils were to learn that which the Department demands, they would have to leave something else unlearned?—Yes; and I think I may say that if we were to get them up for the department examination, we should give them a course in almost all respects inferior to that which we give at present, and I should be very sorry to spoil our teaching to that extent.

6264. (*Professor Huxley.*) Do you not think it quite possible in the instruction which you give, to impart some sound instruction to students of the age in question in all the topics mentioned in my book, for instance?—I do not think that in a two years' course, that book could be well prepared for a written examination by artisans.

6265. How many lectures are given in each year?—I believe 25 is the minimum.

6266. Do you really not think that with such teaching as you describe, 50 per cent. of that class of artisans might be made to understand intelligently all that is embraced in that book?—I do not think so. I should not undertake myself so wide a course.

6267. (*Chairman.*) What is your opinion as to the effect which the science classes hitherto formed in the west riding of Yorkshire have had in forming a genuine body of science students?—The science schools in connexion with the Department have not been so long established in Yorkshire as in some other parts of the country, not so long, for example, as in Lancashire. And therefore it is, perhaps, not quite fair to test their results too strictly, but we have noticed that, although

L. C. Miall,  
Esq.

9 March 1871.



L. C. Miall,  
Esq.

9 March 1871.

for some years past there have been a considerable number of students who have passed those examinations regularly, they disappear, they do not turn up again in the town. We never find them taking situations in connexion with the manufactories. We never find them belonging to any of our art and science associations, they pass out of view; and there is a very marked difference in that respect between the students who have passed through the Philosophical Society's classes, and the students who have passed through the Science and Art examinations. We find that the young men who go through a year's course of our class teaching, or a two years' course, remain with us year after year. They become habitual frequenters of our library, they become subscribers to our society, and we keep hold of them permanently; in fact we look upon our science classes as the great feeders to our society, for they bring in just the sort of men whom we want to lay hold of, whereas we get none from the Science and Art Department students. This might be partly explained by the fact that our subscription is perhaps too high to come within the reach of artisans; it is a guinea a year. Only lately we had an instance of the very slight number of genuine science students who had been turned out by the Science and Art Department classes. A gentleman in our town offered to pay the annual subscription to the Philosophical Society on behalf of a certain number of young men who were unable to pay it themselves, and he directed me to inquire in the first instance among those students who had passed the Science and Art Department examinations. I consulted with the science teachers in our town, and we got a list of all those whom we could find, who had passed the department examinations, and who were still residing in the town, but out of the whole number we found it impossible to find three who we considered were deserving of this little bonus. There were two whom we considered students of sufficient merit and sufficient perseverance to take advantage of such an offer; but having found two we were obliged to stop, and the other subscriptions were paid on behalf of other people.

6268. Have you any remarks to make as to the building regulations of the department?—There is one small point which I had in my mind at the time I sent in my paper (it is not of any great consequence). There was lately opened in our neighbourhood a large building at Keighley, which is intended, among other things, for science teaching. As the managers wished to get the Government grant, they sent in their plans to be revised. A number of objections were made to their plans; some of them, as it seemed to us, of rather a trivial nature. Quite unimportant alterations were made, but they passed over some rather great faults, and one principal one that was complained of was this: that the science lecture room intended for science classes, and in which demonstrations of various scientific subjects were to be held, was a large room capable of holding 100 persons or so, with a flat floor, and no great height in wall, only about the height of an ordinary apartment. After the plans had been passed by the South Kensington officials the committee found it necessary to recast the room, and to lower one end very considerably, and make a sloping floor, so as to adapt it to the purposes for which it was intended. In our neighbourhood that mistake has been made over and over again, the mistake of providing a large room in which to teach science, making the floor flat and the walls low. In that case those who are far back cannot see what is going on at the table; and the efficiency of a lecture theatre is so much affected by that that I think it would be well if in all cases a suggestion were made to managers that some such form of room as that is almost indispensable for good teaching.

6269. (*Professor Smith.*) When you spoke of examination by written papers as being an insufficient test of merit, did you intend to suggest the propriety of *virâ voce* examination?—I think it is perfectly indispensable.

6270. Do you think that that would also be practicable in the case of such examinations as those under

the Science and Art Department?—It certainly would not be easy. I see at once very great difficulties that would be in the way, but I attach so much importance to it that I should be disposed to consider the question with the view of removing the difficulty, and even at the risk of very seriously diminishing the number of candidates, I would still have a practical examination.

6271. And at the risk of adding very greatly to the expense of the examination?—It appears to me vital and essential to the efficiency of the system.

6272. (*Professor Huxley.*) Do you think that the facts which you have very justly mentioned as incidental to the present system do not appertain to all kinds of written examinations?—I think so most decidedly.

6273. You are doubtless aware that a few years ago a medical student of average cleverness could very readily pass the examinations by devoting three months to a grinder, instead of working for three years, as it was his duty to do?—Quite so.

6274. So that those faults that you point out are not the special property of the system of the Science and Art Department at present, but rather inherent in it as a mere written examination?—Yes, I am quite of opinion that they belong to all purely written examinations of the kind.

6275. You spoke of an objection existing on the part of some of the Bradford teachers to the Science and Art system, can you tell us anything about Keighley?—At Keighley the committee have very recently formed a trades school, and have been considering the whole question with the view to establishing such a course of instruction as will promote the interests of the neighbourhood; and they have endeavoured to estimate, so far as they can, the advantages and the drawbacks attending the system of instruction connected with the Department. Their final course is not yet determined, and I think they are disposed to make experiments, to try various plans before they ultimately decide upon their final system. At present they have not established any classes in connexion with the Science and Art Department. They have established a set of, I think, five or six science classes, employing teachers who are not in connexion with the department, and paying them out of the funds of the institution, or out of the fees. They have just got a master for their trades' school, who is qualified to teach, I think, a very great number of subjects under the department—11, if I mistake not. He is anxious to establish a number of science classes in Keighley at low fees, in order to get a large return of payment out of the Department, and the committee is at present considering whether to accept his proposition or not. I think their feeling is that if they do consent, it will be mainly out of regard to the teacher's interests; but I think that until the regulations of the Department are something very different from what they are at present, they will in any case maintain, for the sake of diffusing scientific knowledge, a few science classes independent of the department altogether.

6276. So that on the whole the committee of the Keighley institution has felt considerable hesitation in coming in to the regulations of the Science and Art Department on the ground that you have mentioned?—I am not at all authorised to speak on behalf of the committee. I do not belong to it; but that is my own personal view of the matter certainly.

6277. Have you considered any plan by which the existing system of giving scientific instruction in connexion with the Government could be made more thorough than it is at present; for example, suppose that a certain curriculum were established, that there were systematic teaching on a scale of graduated subjects, that an examination were taken at the end of the first or second session, we will say, and that a scale of payments were made upon the results of those examinations equal to those which are made upon the present haphazard examinations, do you think that that would in any way meet the difficulties and imperfections at present existing?—I think there would be a good deal to be done by introducing some such



system as that which you sketch out. It would appear to me that the essential and cardinal faults of the present system are, first of all, that the training and teaching qualification of the teachers is far too low; secondly, that, owing to the entire absence of practical examination, a very defective style of teaching is encouraged; and thirdly, that it is at the option of a teacher to take any subjects he pleases in any order, just according to either his own caprice or some accidental opportunities that he may have had. For example, a teacher in a large town may begin with such a subject as mineralogy, which certainly ought to follow upon other and wider subjects. He is at liberty to take any one subject out of the whole syllabus. I think it would be eminently desirable that some selection should be made out of the whole subjects in the syllabus, say, two subjects, which are to constitute the course of instruction for the first year, and perhaps the same two subjects again, with the addition of a third, which might constitute the course for the second year.

6278. Supposing that we took physical geography in its widest sense in the first year (by which I mean the general description of the phenomena of nature), and combined with it a certain amount of elementary physics, would that make a satisfactory basis for a first year's course?—I think that that would do exceedingly well.

6279. Then you might take in your second course a further knowledge of physics and chemistry probably?—I am not quite sure that I should not put chemistry in the first year's course. That, however, is a matter of individual opinion, but some such course as you propose would be exceedingly valuable.

6280. Would you have an examination at the end of each term?—Yes, I think that would be necessary.

6281. Do you think, as a practical point, that if the Department were to pay upon that examination, in the same way as they would pay upon an examination in two subjects, taking them haphazard, that would suffice to remunerate the persons engaged in teaching?—If you mean retaining the present regulations in other respects pretty much as they are as to the number of lessons, and so on, I am not quite sure that I can give an opinion at once as to the pecuniary results to teachers. I think you introduce the consideration of a practical examination at the end of the session. Of course if there is a practical examination at the end of the session in such subjects as chemistry, it would bring some extra expense upon the teachers. The best chemical teachers are placed at rather a disadvantage at present in that respect. They have to incur extra expense, and of course if the practical examination were made more efficient they would have to go to still more expense.

6282. Grants are already made by the Department, are they not, in view of that expense?—Yes.

6283. But to make the matter as simple as possible all that would be required for the establishment of a school of the kind that we are now talking about with the existing regulations, would be that the Government should undertake to pay for the results of the final examination exactly the same sum as they pay now upon separate subjects?—Yes.

6284. How far do you think that that could be carried out in practice so as to answer the purposes of the teachers?—If a course such as you have briefly sketched, ending in a practical examination, could be established, and payment were to be made on the result of the entire examination, of certain sums, proportional to the existing rates, I think there would be no difficulty in getting together the teachers, but I must say that I think it would be necessary slightly to increase the rate of payment in view of the much greater expense and trouble involved in getting up a pupil for an efficient examination, because it is a very easy matter to pass a pupil by books and blackboard work in such subjects as chemistry, but it is very much more difficult to do if you make the teaching real. A great part of the experiments may be omitted if they are to be followed only by a written examina-

tion, whereas they must be gone through and studied thoroughly, if there is to be a practical examination. I think it would be fair to the teachers to increase the payment beyond what the present regulations afford, if you are to introduce such a system as that.

6285. That difficulty would be met, would it not, by counting practical work as so many marks in the examination?—In part; but even then, I imagine, it would be a more expensive and troublesome thing for the teacher, and would impose fresh work upon him. But that is not a point of the first importance. I do not know that I have any well-considered opinions as to payment, but I am certain of this, that such a system as that would draw into the service teachers who now stand aloof from it. I may mention that if anything of that kind were introduced, and the regulations permitted such a class, I would myself very gladly take charge of one or more in concert with somebody else. It is the kind of work that I should gladly throw myself into on the understanding that there was to be a good, sound, practical examination at the end of it, but on no other terms.

6286. In that case you would substitute science schools for the existing system of haphazard scientific examination?—Yes, a definite pre-arranged course.

6287. (*Chairman.*) You would have fewer pupils taught, but those that were taught would receive efficient practical instruction, and at a somewhat higher cost per pupil?—Yes, I think that if the system of practical examinations were introduced, it would almost certainly, at first at any rate, reduce the number of candidates, and I think that it would increase the cost. These are two very likely consequences.

6288. (*Mr. Samuelson.*) From your experience of the results of the actual system as distinguished from the one which you have just sketched, are you of opinion that any impression has been made by that system upon the country at large, or take, for example, your own district in Yorkshire?—If I were to speak of our own district I should say that the impression made is next to none, that we might sacrifice all of it, and that it counts for next to nothing, but I would not extend that judgment to the whole country, because I believe there are many parts of the country where the system has worked to much greater advantage than it has done with us.

6289. Are there any special reasons why the system should have worked less advantageously with you than elsewhere?—It has been in exercise a much shorter time, and I think I may say that we have had a rather inferior set of teachers, but that is largely accidental. We have in our neighbourhood two men who are students of science; but amongst all the science teachers in our neighbourhood, with whom I am acquainted, I do not think I could mention more than two who are in any sense of the word "students of science." I think that the proportion is much lower in our case than it is elsewhere. In a large proportion science teachers in general do feel some more real interest in the subject than is the case with us.

6290-1. Assuming the present system to be maintained, do you think it would be advantageous to have a preliminary examination of no very high degree in literary subjects before pupils should be admitted to science classes?—I think that certainly would be desirable, because in chemistry, for example, the master has very often to spend a large part of his time in explaining decimal fractions. I know an instance in the village of Saltaire, near Bradford, where the chemical master has had to pay very considerable attention to the arithmetic of his students there, for they would not be able to pass the examination otherwise.

6292. Are there any practical reasons, taking into account the condition of instruction of our manufacturing population, which would render such a regulation unjust to them?—I do not think there would be any great amount of injustice in it. My opinion would be that a certain amount of what may be called literary instruction would be almost necessary

L. C. Miall,  
Esq.

9 March 1871.



L. C. Miall,  
Esq.

9 March 1871.

before scientific instruction could be profitably communicated. I do not think that individuals would be injured by being excluded from science classes until, for instance, they were acquainted with the elements of arithmetic, reading, and writing.

6293. But although some persons might perhaps be excluded upon the whole the majority would be very much better taught?—Yes. I think it would be an advantage; but the standard certainly should not be high, but quite an elementary one.

6294. Would you be of opinion that such systematic courses as you have spoken of should be substituted for the present system, or that they should be super-added to it?—There would be considerable difficulty, and something that would almost amount to unfairness, if the existing regulations were to be hastily superseded, and I should not wish to recommend that. I think that a connected system of elementary instruction might very conveniently grow up side by side with the existing regulations; and the amount of modification need not at first be very considerable. That would work in very well with the rest, I think. You might have such classes perhaps conducted by the same men who are conducting classes according to the existing regulations. It would not interfere with the existing classes, or injure the prospects of the present teachers.

6295. Are you of opinion that societies like 'your Philosophical Society and the various Mechanics' Institutes in Yorkshire would be prepared to make some pecuniary sacrifice in order to introduce those systematic courses?—I am quite certain of this, that if they were satisfied of the efficiency of the system, they would do so. I cannot say how they would look upon such a plan as that. I am not in a position to speak for them, and say what they would give to such a system, but our institution does at the present moment spend large sums of money for the support of scientific instruction. Our own society spends a considerable sum of money every year in supporting teachers, and our Bradford Mechanics' Institute is about to spend a large annual sum on teachers. They are going to pay handsome fees, and if they could be persuaded that such a connected course of elementary scientific instruction would attain the object they have at heart, I think they would give it every possible assistance.

6296. Supposing that the Department of Science and Art were to say, if you gentlemen of the locality will contribute a handsome sum in subscriptions towards the establishment of systematic science teaching, we will aid you in some form which shall be approved, do you think that that would meet with a ready response?—I am not altogether sure how that would be received. I cannot answer for it if the proposition were made in that form. Our people naturally would not so readily contribute a sum of 50*l.* a year or 100*l.* a year to be expended at the direction of the Department, as they would contribute a similar sum to be spent by their own officers. I am not quite sure that such a proposition as that would call forth much liberality. It might or it might not.

6297. Do you think that they would be more ready to spend 100*l.* at their own discretion than to spend a similar sum with 100*l.* added from the Science and Art Department, subject to the regulations of the Department?—I am not quite sure how they would feel about it. In our town there is a good deal of dissatisfaction with the doings of the Science and Art Department. I do not think that there is a great deal of confidence in them, and I am not sure that such a proposition as that would meet with any very great support.

6298. Do you think that a systematic course of instruction of the kind which you have described, is likely to be given in your neighbourhood without the assistance of the Science and Art Department?—It is being given, but it is not given to the same class of persons. It is not being given to artisans, and I do not think there is any prospect that it will be given to artisans for some years to come. A connected course of instruction such as has been described, is now being

given in our town, but it is to the middle classes and upper classes of the town.

6299. What are the obstacles to the working class availing themselves of that instruction?—There is no great obstacle in the way, except that the class is composed of another set, and therefore it does not come in their way. That is the principal obstacle. The fees are low, being only 5*s.* for each course. But it does not come exactly in their way, and it is not brought prominently before their notice.

6300. Is it a sort of antagonism between broad cloth and fustian which prevents the amalgamation?—No doubt there would be something of that feeling. I daresay a genuine artizan would not feel thoroughly comfortable in the class. At any rate, that would be possible.

6301. Can you state what have been the results of the classes of the Philosophical Society?—We look upon the classes as a great success, chiefly on this ground, that out of our classes have come a number of young men who are now active supporters of our society; good students, many of whom have taken, for example, to working with the microscope, have taken to field work in geology, and have taken to various practical scientific studies. Some of them are in their own neighbourhood among their own friends getting up fresh classes around the town. We have three students who have passed through our classes who are now doing that sort of work, organising little societies in their own district; and in fact we consider that perhaps the best blood in our society has come from the young men who were first of all introduced to us through our classes.

6302. Can you speak as to the technical and industrial results?—Those have not been considerable, in fact hardly important as yet, and that is very largely due, I think, to the circumstance that the teachers of whose services we have been able to avail ourselves have not been strongly interested in industrial pursuits. Some of our most successful classes have been classes in physiology, natural history, and geology, and other subjects which are not so immediately connected with industrial pursuits. That has resulted not so much from choice on the part of the managers of the society but from accidental preferences of the teachers. We are intending this summer, if possible, to introduce a class for instruction in the chemistry of dyeing. That is of course quite an experiment, and I do not know yet whether it will meet with any success.

6303. Would you answer the same question with reference to the science classes in connexion with the Science and Art Department?—I do not think that in that case the effect is appreciable. I do not think indeed there is any effect. If the science classes in connexion with the department were to go on for 50 years as they are doing at present, I do not think they would produce any perceptible effect upon the industrial occupations.

6304. You spoke of the results of the examination by the Department of Science and Art in zoology. I see that by the last directory the only classes at Bradford are in magnetism and electricity and in inorganic chemistry; is it within your knowledge why the biological classes were discontinued?—I do not remember that there was a class in zoology in Bradford. If you remember the case which I cited was that of a teacher who was qualified to teach zoology. He actually teaches chemistry, electricity, and magnetism, and he authorised me to state on his behalf that fact respecting zoology. I do not know in what town he passed in zoology, but he was not a student in our class.

6305. My question was with reference to the young men taught by your Philosophical Society, and who were examined by the Science and Art Department?—They sat at the same examination with others who had been trained in the Science and Art Department classes; but we had no class of ours for them. Our classes are not in connexion with the Department, and of course they do not appear in the report, but our pupils happened to go up for the examination.

6306. In point of fact there was no opportunity of comparing your students with those of any class in



connexion with the Science and Art Department in the same subjects in Bradford?—No.

6307. You spoke of a teacher having been engaged at Keighley who was qualified in a great number of subjects—what did you mean by his being qualified?—He is qualified to earn payments on results in those subjects.

6308. Assuming a course of systematic instruction like that which you consider to be desirable to be organised, are you of opinion that the same number of students of the condition in life now demanded by the Department, in order that payments may be made on results, would pass as under the present system?—I think the probable immediate effect of a systematic course would be to reduce the number of students; probably fewer would enter for a course embracing four or five subjects, than for a single course on one subject, that is to say, if that were proposed as a substitute for the existing regulation.

6309. So that at first at any rate there would be a pecuniary loss to the teachers?—Not necessarily. I would propose myself, as I mentioned before, that the new and systematic course should be allowed to grow up side by side with the existing regulations, and in that case it would involve no loss to the teachers under the present system.

6310. But assuming it to be substituted you think there would be a loss?—I think very likely there would be.

6311. But if the regulation were to be withdrawn which limits the payments on results to artizan pupils, do you think that in that case there would be such an accession of pupils of other grades as would compensate for the diminution of the remuneration derived from the artizan pupils?—I think that it would very much more than compensate. It would be very much to the profit of the teacher if any persons from any class of society could earn payments on results, because some of these would be persons of better education, and therefore better able to do justice to what teaching they had had, and also be more easily persuaded to join science classes. Generally speaking it is more easy to persuade a young man of the middle classes who has received a good school education to join a science class than it is to persuade an artizan.

6312. Then you think that the suggested new system not limited to artizans as regards payments on results would pay the teachers better than the old system limited as it now is?—Very much. It would make a very important difference indeed, I imagine.

6313. Those pupils of a higher grade would probably not be indisposed to pay some moderate fee to the teachers?—No, they do that at present very readily.

6314. (*Dr. Sharpey.*) Supposing that the Science and Art Department were to introduce a plan of practical examinations such as you suggest, by what agency would they be carried on?—I do not know that I am prepared to sketch out a system; but I should imagine that it would be necessary to provide a considerable staff of assistant examiners, who would go about the country and conduct the practical examinations as near as possible about the same time. It would not be necessary that they should be absolutely simultaneous. They might be conducted in the same period of three weeks, for instance. I think it would be necessary to have a staff of say 30 assistant examiners to examine at various centres up and down the country.

6315. And those, I presume, would be paid by the Department?—I suppose that would be necessary.

6316. (*Mr. Samuelson.*) Do you think that only 30 would be enough?—I cannot say exactly. I think that the students might be required to travel a little further than they do at present. It would not be necessary to have an examination in every town and village.

6317. You would suggest something like the mode in which the Cambridge and Oxford Local Examinations

are conducted?—Yes, only there might be rather more centres than they provide. They provide only a very small number.

6318. (*Dr. Sharpey.*) I think you objected to the examination papers set by the examiners in the Science and Art Department, that the questions in each subject went over too wide a range. Are you aware that the object of that is not that the candidate should be required to answer upon every question, so that he should be obliged to go over the whole range, but is rather intended to give an opportunity for pupils that have been educated differently in different places to find out some questions which they can answer, and some subjects on which they have been prepared?—I think that that interpretation is not quite consistent with the regulations; practically it is necessary for the teacher to go over the whole field in some sort at any rate, or else he runs the risk of getting his pupils plucked. Take chemistry for example. The chemical examiner has made a point of late years of putting in at any rate one question of a practical kind, the correct answering of which is indispensable to passing; but that one question may be based upon any part of the syllabus; and therefore if the teacher omits any part of the syllabus, he runs the risk of having the practical question taken upon that part. Nevertheless the teachers do run that risk. A chemical teacher tells me that for some years past he has invariably omitted a great part of the chemical syllabus; he has always taken his chance of all his pupils being thrown out, but he finds that that is better than taking the whole syllabus.

6319. Do you not think that the very fact of there being only one question makes the difficulty? Supposing there were four or five questions of that kind, do you not think he would have a better chance of passing?—Yes.

6320. So that the teacher might perhaps take up a particular part of the syllabus and go more thoroughly and fully into it, leaving out other parts, and yet his pupils might have a fair chance of doing well?—Yes, that would be possible now in some subjects.

6321. (*Chairman.*) Have you considered whether, instead of allowing teachers to obtain certificates that they are qualified to teach science in a great number of subjects which they must have studied superficially and only in an elementary form, it might not be more expedient to require them to pass a much more efficient examination in a group of subjects and to restrict their teaching to one or two such groups?—I think that the qualification for teachers is far too low at present, and therefore it is a comparatively easy matter for a man to get a certificate in a very large number of subjects, or even in all, and be ready to teach one or more of them as opportunity offers, according to local or temporary circumstances, and in many cases the teachers who are thus qualified to teach almost every subject that comes under the head of science have no real acquaintance or interest in a large number of them. I think it would be eminently desirable to restrict them, not too much, because sometimes there is only one teacher for a large district, and it is rather desirable that he should have a tolerably wide range. At any rate it would be desirable that he should be to a certain extent restricted, and should not be allowed to cover the whole range or anything like it.

6322. Have you any knowledge or experience of the system of itinerating organising masters in relation to such instruction in groups of subjects?—I have not. I have no practical acquaintance with the teaching of itinerating masters.

6323. Have you anything else that you would desire to state to the Commission?—No, I think that I have brought out all the most important points that I wished to mention.

The witness withdrew.

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9 March 1871.



THOMAS COOMBER, Esq., examined.

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Esq.

9 March 1871.

6324. (*Chairman.*) I believe that you have been head master of the Bristol Trade School for 15 years?

—Yes.

6325. Prior to that you pursued the study of science at the School of Mines and the College of Chemistry in Jermyn Street in London?—Yes.

6326. You have likewise had experience in a mining school which had been affiliated to the Bristol Trade School during that time?—Yes, during the whole time.

6327. And with the encouragement of evening classes for teaching science to the operative classes in Bristol which have been in existence about 11 years?—Yes.

6328. Besides this you have held lectureships in chemistry to societies and local associations in Bristol?—Yes; two lectureships.

6329. As the head master of the Bristol Trade School, will you be good enough to describe to the Commission to what extent the instruction in science has been introduced into that school?—We teach mathematics and the applications of mathematics to mechanics and mechanism, descriptive geometry, and the applications of descriptive geometry to machine drawing and building construction—in one word, artificers' drawing. In addition to that we teach chemistry, both inorganic and organic, and experimental physics, which includes electricity, magnetism, acoustics, light, and heat.

6330. Will you inform us what amount of practical instruction and manipulation is connected with those several studies?—Up to the present time, so far as the day school is concerned, nothing very systematic has been done in that way. A certain number of the boys have been employed occasionally in the preparation of experiments, but the systematic teaching is confined, as far as the day school is concerned, to several boys who have been withdrawn from the school, and have become apprentices as chemists. They are solely employed in practical work: that is to say, chemical analysis, and the preparation of experiments for illustrating the lessons in chemistry and physics.

6331. Have you the apparatus and all the necessary appliances for instruction and illustration of whatever lessons you give in chemistry and experimental physics?—Yes, every scientific fact that can be illustrated by experiment, and be demonstrated by experiment, is so taught by us.

6332. Is your apparatus satisfactory in extent?—As far as chemistry is concerned, perfectly so. Our apparatus as far as physics is concerned might be added to with advantage, although it is good as a collection.

6333. Are your rooms for teaching drawing convenient?—Yes, the rooms are well adapted for the teaching of drawing.

6334. What is the connexion of the affiliated mining school with the Bristol Trade School?—The connexion has varied in the course of time. The mining school originally was under a perfectly independent management. This mining school owed its origin very much to the late Mr. Mackworth, the inspector of mines in the west of England, and owing to Mr. Mackworth's exertions a considerable fund was obtained from the coal masters in our neighbourhood and in the neighbourhood of South Wales to sustain the school, but it will be in the memory of gentlemen present that Mr. Mackworth was carried away by a premature death, and the support which he had been the means of obtaining for the school immediately fell off. The school then languished, and it was determined to make this alteration, that its fees should be of a character which should in themselves remunerate the master who is engaged to teach mining, but we have not been very successful. Unless the gentleman who is engaged in teaching mining with us had had other sources of income as a mining engineer, we could not have continued to offer to the public a mining school.

6335. Have the students of the mining school an opportunity to attend your instruction in chemistry and

in drawing in the Bristol Trade School?—Yes, that was the intention of the affiliation of the school to our institution, to economise by taking advantage of the teaching offered by the trade school.

6336. How many mining students now attend the Bristol Trade School?—Only six.

6337. Have you any other connexion between the Bristol Trade School and any of the industries of the district in which science is applied?—No, save in the case of the evening classes. An association of pharmacists has been formed mainly for the purpose of encouraging their apprentices and assistants to take advantage of this teaching.

6338. To what trades do the youths who receive education in the Bristol Trade School commonly devote themselves?—To the manufacturing and mechanical trades. Chiefly mechanical trades, including the construction of machinery and building. A few go into commercial life, but there are very few of our boys who do not become mechanics. They see the advantage in doing so which their education gives them.

6339. Is there any system by which a boy having acquired a certain amount of such knowledge as is given in the Trade School can afterwards go to a building or mechanical trade for a time and acquire manual dexterity and a knowledge of materials, and then return to the Trade School to perfect his theoretic instruction?—No, there is nothing of the sort. This is what really takes place. The boys who are educated with us and leave us at ages varying from 14 to 15, continue with us their education after their day's work, in the evening school.

6340. So that by such means youths who have obtained a certain amount of theoretic instruction in the school are enabled to improve themselves in the evening whilst they are engaged at work?—Yes, and this is really done; a good proportion of the young people in our night classes are youths who were educated as boys with us.

6341. Have you any system of public examination of the school by an independent authority?—There is no examination by the local authority. We resort for examination only to the Department of Science and Art.

6342. Are there connected with the school, or have there been made available any scholarships by which any of the youth could be transferred to technical schools or other higher departments for acquiring scientific knowledge?—We have a scholarship awarded to us by the School of Mines in Jermyn Street. That is a free exhibition to the lectures, and three of our students have availed themselves of that. The object of that scholarship is to foster the study of mining in the school.

6343. Have you been able to follow the career of those students?—Yes; one is the manager of a colliery in South Wales. The other is now engaged in the development of a coal-field at Natal, and the third used the education which he acquired at the School of Mines in London, to obtain a science scholarship at Cambridge, and is still at Cambridge.

6344. Do you think that the connexion of such scholarships and exhibitions with the technical and scientific schools or colleges, would promote the interest of the Bristol Trade School?—There is no doubt about it. Moreover, I could always offer boys or young people who would be well able to take advantage of such opportunities.

6345. Your school would afford, in fact, a very favourable system of training by which young men might, with the aid of such scholarships or exhibitions, be transferred to the highest departments of technical instruction?—Yes, certainly.

6346. At what age are youths received into the schools?—You must understand that our school is not entirely devoted to the teaching of science. The notion of the gentlemen who established the Trade School was that it should be so, and that we should deal only with the boys who had completed their education so far as it could be completed in the



local elementary schools, but directly we got to work, we were faced by this difficulty, that those very boys whom we had hoped to attract to the school, were the boys whom the masters of elementary schools were least disposed to part with, and we therefore saw that we must make our own elementary school, if we were to feed the science part of our school with a proper supply of boys. Consequently, we at once set to work to make a thorough elementary school, which should be introductory to the science department of our school. There are now 160 boys in the school, and out of this number upwards of 100 are not learning anything of science at all. They are learning a little practical geometry in connexion with the examinations of the Department of Science and Art, that is all; but the remaining 50 or 60 are doing the work which I have already delineated, so that you see two thirds of the boys in the school are learning nothing but what is taught in an ordinary elementary school. We take boys into that part of our school at ages varying between 10 and 11. I do not think we have any younger than 10; they pass from the elementary part of the school into the science part at about 12, and remain until the age of 15. There is this bar to our keeping them longer, that masters refuse to receive boys as apprentices after that age, so that those who are going into mechanical trades must perforce leave at 15, but still we have some boys older than that. We have one or two boys in their 17th year, but there are practical difficulties of a disciplinary character in the way of keeping boys longer than the age of 16. It ceases to be a boys' school, and requires a mixed treatment, which would be practically a difficult matter.

6347. What proportion of the 100 boys who are in the elementary school does your experience lead you to expect will pass into the science school?—There are very few indeed who do not pass into the science school. They enter with the full intention of passing into the science school. There are some who come to us with no intention of becoming mechanics, but of becoming clerks, and they come to us for the sake of the sound elementary education which we try to give, and it being quite decided that they are to follow a commercial life, I never recommend them to enter into the technical division of the school, but directly their education is as sound as we can make it in the elementary part of the school, I suggest that it is time for them to be getting out into the world.

6348. Then the knowledge of the boys who are taught in the elementary school is probably sufficient without requiring them to pass any test examination before being promoted into the science school?—Yes; but we do in practice give an examination. We pass boys from the elementary part of the school into the upper part of the school by examination, in order that their fellows may be quite satisfied that they are fairly promoted. However, we do not receive those boys whom our experience has convinced us cannot take advantage of the teaching that we have to offer in the upper division, although their attainments might reach the standard which would warrant their being passed up.

6349. Can you inform the Commission as to the degree of success in the mechanical and building trades attained by the youths who have been trained in your school?—As far as I have been able to follow the boys they are all occupying respectable positions, and they are doing better than they could have hoped to have done had they not received our education. But the time has not yet elapsed to enable us to judge. Our boys have hardly become men. This is but the 15th year of our establishment, and therefore no very striking amount of success could be looked for, but the boys who have left us are, as a rule, doing very well indeed.

6350. What is your impression of such scientific instruction as has been given as a means of mental training and discipline and as fitting youths for success in life?—As far as its value as a mental training is

concerned, I attach a very high one to it indeed, inasmuch as not only is a rigorous treatment demanded to ensure success in the studies that we take up, but the boys themselves form a liking for their work, which, as a body, they evince in the study of experimental science especially, and this brings a very splendid spirit to that rigorous treatment which scientific studies demand.

6351. If you had the means of creating laboratories for chemistry and for experimental physics in connexion with the school, would you think it expedient to combine practical instruction in those laboratories—with the system of instruction adopted?—I think it in the highest degree expedient. The only reason why it has not been done by us is a question of time. Could I afford an hour in the day to devote to the teaching of practical chemistry to the upper form of the boys in the science part of my school, it would be done now; in fact we should have found time at the present moment for it, but unfortunately one of our masters had fallen ill, or else this was really contemplated, and will be attempted.

6352. You would also find it necessary to increase the staff by means of assistants?—It so happens that just at the present moment, as I have mentioned, I have several apprentice chemists; those are now young men and could afford all the assistance that I should require at present, but I could not rely upon that permanently. I should require assistance.

6353. What is the actual staff of the Bristol Trade School, first of the elementary, and secondly of the science school?—There is no such division of the staff as your question contemplates. There is only one master who is not engaged in both divisions. There are four masters, each of whom takes his share in the general literary work of the school. One master devotes himself more especially to mathematics, another to descriptive geometry and its application to machinery and to building structures, and to applied mechanics; and I devote myself to chemistry and experimental physics. We have also a mining master who will make a fifth master.

6354. If you were to extend your instruction to manipulation, you would require more assistance?—I should want a good laboratory assistant.

6355. Have you made any statement to us of the whole annual expenses of the school and the fees paid by the students?—Our fee is 3*l.* per year in the trade school, and in the mining school an additional 7*l.*, in all 10*l.*, so that our income for the past year will be very nearly 450*l.* from fees. I speak of the trade school only. The additional mining school fees go entirely into the pocket of the master engaged in teaching mining, and those fees are his only emoluments.

6356. Are the Commissioners to understand that the teaching of 150 scholars in the trade school, and the management of the evening school is conducted by the four masters?—Yes, with the assistance of additional masters for the evening classes. But this statement of fees only applies to the day school. In addition to this source of income there is a small subscription list amounting to 50*l.* a year, and we have the rent of our cellar which amounts to 20*l.* a year, minus income tax, so that our income for the past year, so far as the day school is concerned, independently of the resources which we draw from the Department of Science and Art, will be a little over 500*l.*

6357. You would have either to increase the fees or to obtain means from other sources if you added laboratory instruction, both for additional assistance and for the cost of the apparatus, and for materials required to conduct experiments?—Yes; I entertain a very strong conviction that experimental physics could be treated in very much the same way in which chemistry is treated, and that it never will be studied properly till it is studied in laboratories set apart for the experimental study of the science, but entail a considerable immediate expense to put ourselves in a position to offer such instruction, and

T. Coomber,  
Esq.

9 March 1871.



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9 March 1871.

would of course entail an additional yearly expense to sustain it.

6358. Supposing that you had *carte blanche*, and were disposed in the most economical way to apply the resources put at your command, what other subjects of scientific instruction would you think might be introduced into the education of the same classes of persons as those who now attend the Bristol Trade School?—I do not think that we could add to our curriculum with advantage. It is possible that subjects might be added to the studies of the school, provided a classification of those studies were made; but unless a classification of studies were made, I do not think that we could make any addition.

6359. I understand you to mean that the same boy could not learn other subjects, but my question had rather reference to the whole range of education and the peculiar talents and tastes of youth. Looking at it in that sense, have you thought whether or not it might be expedient to include in the curriculum of a scientific school for that class any other subjects than those which you now include?—I will answer your question, if you please, in this way: provided I had the means of obtaining a sufficient staff to do it, I could make such a change as would be greatly for the advantage of the pupils. I might say to the scholars after they have passed a certain time in our general course, "Will you elect your future pursuit, because your education shall be adapted to it?" We might add sciences to my curriculum, if we had the means to make such a classification, but directly we look in that direction, we are faced by the expense which an additional staff must of necessity involve. Now, of course, all the sciences that we study are studied in common by every boy, speaking as a rule.

6360. Taking up the same view of a considerable enlargement of resources, has it occurred to you that any means of supplying instruction connected with the trades of the district, could be added in Bristol at the Trade School?—I have contemplated introducing this sort of teaching into the night classes, that is, to invite certain practical scientific men to assist us, and I begin to see the practicability of this, inasmuch as there are several young men in my hand who have been educated by us who have acquired skill as practical men. I have thought next winter of inviting an old pupil of mine who is connected with an alkali manufactory, to give a course of practical lectures upon chemical construction. Then, again, I have another pupil who is a very good practical engineer; he is the sub-engineer of the gasworks, and they have done a very great deal of building of late years, and I have thought of inviting him to give a course of 8 or 10 lectures to artificers in the practice of construction. That sort of thing I have contemplated, and it would have been done had I found the material to my hands to do it with. I begin to see that I have such, and shall make such an attempt next winter.

6361. (*Professor Huxley.*) Do you not think that the elementary scientific teaching of boys in the school might with advantage begin somewhat earlier than it does?—I do not think that boys are to be prepared for the rigorous examinations of the Science and Art Department at an age younger than 12. Every boy who learns science is expected to present himself at the examination of the Department, and we could not commence that work with any prospect of success at an age younger than 12.

6362. In what class of the examination do your boys present themselves, in the advanced or the elementary?—In both, beginning with the elementary.

6363. I think that is now compulsory in all the subjects, is it not?—Not compulsory, but no lad can receive a prize in the second grade who has not made his appearance in the first grade. A year back the Department also laid stress upon their desire that young people should offer themselves in the elementary grade first, by refusing all aid to the teacher unless the boy had first passed in the elementary stages. That regulation, however, is withdrawn.

6364. Do you think it is advantageous that candi-

dates for examination should be made to pass in the elementary stage before allowing them to take the advanced stage?—Yes, certainly.

6365. You do not give your boys any sort of scientific instruction before you begin what one might call their more precise and severe studies?—No; because you will see that there is very little time in the upper school devoted to literature, and that unless we devoted our whole time to making that very sound before a boy reached the age of 12, he would leave us with a very imperfect education.

6366. Then I understand it is rather on account of the necessities of the case than because you suppose that boys are not competent to receive scientific instruction earlier, that you do not begin it earlier?—From my practical knowledge of boys, I say that, as a rule, you will not get sufficient brain development before the age of 12 to deal with the rigorous study of science. I do not mean to say that you may not bring about the reception of a few popular scientific truths, but a boy is not old enough for the rigorous study of science till after the age of 12.

6367. Do you imagine it impossible to teach a boy, we will say elementary botany, before he is 12 years old?—I have had no experience in teaching botany; my experience has been entirely confined to the teaching of mechanical physics, experimental physics, and chemistry.

6368. Do you confine your opinion entirely to those subjects?—My opinion is worth nothing outside those subjects.

6369. (*Professor Smith.*) Do not you give mathematical teaching before the age of 12?—Yes. Boys pass into the upper division with some knowledge of algebra and also with a knowledge of vulgar and decimal fractions, and the best of them have commenced algebra.

6370. And in geometry also?—Yes. In those cases where we can do so. Euclid is our text book in geometry, and wherever we can do it with advantage we carry the boys of the second division through the early propositions in Euclid, which is our greatest mathematical difficulty.

6371. (*Professor Huxley.*) Do you think that a boy could not be taught the leading properties of, we will say, the principal gases and metals before he is 12 years old, that is to say, supposing that to be the equivalent of elementary chemistry, would it not be possible to teach a boy in a very precise and accurate way, so far as it went, the properties of the principal gases and the most important metals before he was of the age of 12?—There are many points in both chemistry and physics that even a younger boy than that would find no difficulty in comprehending; but I speak of the rigorous treatment of the subject which is demanded of the boy who is to present himself at the end of the year for examination.

6372. You stated just now that it is very possible to give popular information. The word "popular" is very commonly used to signify loose, and imperfect, and superficial; but do not you think it is quite possible to give elementary knowledge of the kind I am supposing which, although limited, may be perfectly sound scientific knowledge, as far as it goes, to boys under 12?—This is what I mean. There would be no difficulty in teaching a boy much younger than 12 the principle of the barometer; but any calculations to be deduced from a knowledge of the principle of the barometer certainly could not be undertaken by a boy under that age.

6373. But I suppose you would have no doubt whatever that a boy under 12, or, indeed, under 11, or at 10 years might be made to understand the principle of the thermometer, the principle of the barometer, the principle of the air pump, and so on, accurately and precisely, so far as the knowledge went?—Yes, there is no doubt of that.

6374. (*Mr. Samuelson.*) Supposing you had to deal with a boy who was to leave school at 12, would you not consider it very desirable to impart some scientific knowledge to such a boy?—I think it would



be of very great value to the boy to have the sort of knowledge which Professor Huxley has indicated; and that is a sort of knowledge that could be given in any good elementary school, and which really all good elementary schoolmasters, as far as my experience goes, are competent to give.

6375. Do you think there would be time during the morning and afternoon instruction to bring the boys up to something really worth accepting without detriment to the three R's?—Yes. I think so, certainly. At the present time in the elementary schools, as a rule, there are certain subjects which are called extra subjects, and this might very well take the place of such extra subjects; I do not imagine that it presents greater difficulties than those extra subjects. One extra subject, for example, is the rather rigorous study of English grammar, and that will involve mental problems of quite as high a character and as difficult of solution as the problems which Professor Huxley has referred to.

6376-7. Your opinion is decidedly that there is no more difficulty in teaching elementary chemistry soundly up to a certain point than there is in teaching the grammar which is required by the regulations of Whitehall to boys under 13?—Yes. The word "sound" applied to such chemistry as you could give under those circumstances would be perhaps a misapplication of the word. If you mean that such information shall be given as would be perfectly accurate, well and good; but nothing sound could be done in that way. You could not teach a boy to think in chemistry. You could teach a boy to know a few chemical facts, but directly he commenced to think, he would get into difficulties and fall into errors.

6378. By teaching him grammatical analysis you pre-suppose, do you not, a considerable power of thought on the part of the pupil?—Yes, an equal power of thought would be required to understand, say, the barometer or thermometer, and especially the barometer, in the way we have been talking of.

6379. (*Professor Huxley.*) Do not you think that a boy who had received the instruction we have been talking about might be able to form an intelligent comprehension of a good many natural processes and phenomena, which otherwise he would be utterly incapable of forming any conception of?—Of course we who know something of science see this. We look at certain facts or certain processes and we see upon what elementary principles they depend. We say, therefore, that but very little knowledge is required to understand them, and we can give that knowledge; but we forget the adroitness of mind which a large amount of scientific cultivation has given us, and which enables us to see that those processes are explained so simply; but such an amount of knowledge I do not think would ever enable a young person to understand the processes of manufacture which he may come into contact with.

6380. I do not mean processes of manufacture or anything so complicated as that, but simply obvious natural phenomena; for example, a boy who had been taught in the most elementary way the principles of the barometer would not make the mistake that the farmer did, who said that he fastened it up for three weeks, and could not see that it made any difference. A boy so taught would not be so hopelessly ignorant as five sixths of the world are upon such matters?—No, and he would have this incomparable advantage over them, that from the very fact of his having received such instruction he would be in a better position to seek and acquire additional information upon any necessary point.

6381. (*Mr. Samuelson.*) Your school with reference to payment by results is of course subject to the restriction that you are only paid upon the results attained by the artisan pupils?—Yes.

6382. Is that restriction rigorously enforced?—We have but few cases which do not fairly come under that category, and we do not claim under them. The Department have never examined our claims in any exacting spirit in that direction, and they would have

undergone no practical diminution if they had. I do not think that my opinion upon that point is worth very much, inasmuch as our people really do belong to the artisan class. There is one exception: we have an association of pharmacutists in the city. They have formed themselves into a sort of guild, and the principal object of this guild is to foster the education of their apprentices and assistants. They engage me to teach these young men chemistry, that is to say, they pay me a certain sum per session to receive their apprentices and assistants as pupils in my lecture course on chemistry during the winter months, and our evening teacher in botany receives the same sum for the same duty. It was a serious point with us as to whether the Department would recognise those young men as artisans, because many of their fathers are certainly men who pay income tax, but they had left their father's house to become pharmacist apprentices; and it was a question whether the Department would consider the position of their parents, or consider them as independent. The secretary of the Pharmacutists Association wrote to the Department and put the question, and the Department by a minute recognised pharmacist apprentices and assistants as artisans.

6383. Suppose the condition with regard to artisans were to be removed, what do you suppose would be the effect upon your classes, distinguishing between the trade school proper, that is, the day school, and the evening classes?—There would be two or three young men in our classes of whom we now ask for double fees, because we cannot ask for the Department grant upon them, who might then be admitted on payment of the artisan's fee, but out of the class of 60 young men who are studying chemistry with me at night, there would only be three such fees to be in part remitted.

6384. With regard to the day school, do you think that you would have any large increase in the number applying for admission into your day school?—I do not see in what direction it could affect the entrance to the school.

6385. At present you would naturally discourage those in respect of whom you are not paid by the Department upon the results of your teaching?—No, we do not, we do not make any difference in the fees. There have been one or two cases in which we could not claim, but only one or two cases.

6386. So that in fact applications for admission into your school do not come from the class above the artisan class?—No; there are five forms in the technical division of my school, and I will state to the Commission the trades of the fathers of the boys who sit upon the fifth or highest form in the day school. The first is a foreman carpenter, the second is a toll collector, the third an operative engineer and fitter, the fourth a photographer, the fifth a clerk at the council house, the sixth an engineer, the seventh a milkman, the eighth a foreman brushmaker, the ninth is the son of a late dissenting minister, and the tenth the son of a national schoolmaster.

6387. Do you receive payment on results in respect of those ten?—Yes, in every one of those cases, I should.

6388. Are you acquainted with any other schools in the United Kingdom similar to your day schools?—Yes, some leading manufacturers at Keighley have established a similar technical school to ours, they have paid us several visits to study the working of our schools, and in fact they are working a scheme which I have drawn up for them.

6389. Is that the only instance with which you are acquainted?—Yes, I do not think there are any others.

6390. Seeing that your school is acknowledged to be successful, can you account for the absence of similar institutions in our other large towns?—No, not at all.

6391. Have you had any peculiar advantages which have contributed to your success?—No, none that I

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Esq.*

9 March 1871.



T. Cumber,  
Esq.

9 March 1871.

know of. We have worked hard, that is the only advantage which we have had to rely upon.

6392. Your subscription list, you say, is very small?—Yes, only 50*l*.

6393. The buildings belong to the school; I believe you pay no rent?—No, we do not.

6394. From your knowledge of science teachers, do you believe that many competent persons could be found to conduct such schools, receiving the emoluments which they would be likely to receive?—I think the best answer is, that the Keighley people have had great difficulty to find a proper person to take charge of their school.

6395. You have mentioned some cases in which pupils of your school have taken the 50*l*. scholarship at the School of Mines. Can you state whether in Bristol scholarships and exhibitions of 5*l*., 10*l*., and 25*l*. have been founded under the minutes of the Science and Art Department?—Yes. The committee of our school last year, from the earnings of the school, devoted four sums of 5*l*. to meet the Department's 10*l*. We had four exhibitions. The Department at that time recognised the students in the night schools as qualifying for such exhibitions, but they have withdrawn that recognition, and will only recognise the students in the day school, and we have therefore now only two exhibitioners. We pay each of those exhibitioners 5*l*. and the Department pay them 10*l*.

6396. Are you aware whether there are any others in the Bristol schools?—I do not think there are.

6397. What kind of school was originally held in the building in which yours is now held?—It was one of the old Adam Bell schools, the national school of the city; but by the introduction of the first education scheme of the government, national schools arose in every parish, and consequently this school became emptied and remained emptied for some three or four years until Canon Moseley became Canon of Bristol, when the trustees of this empty building asked the Canon to give them suggestions as to its employment. That is the history of the foundation of the Trade School.

6398. Was there any interference on the part of any public body, such as the Charity Commissioners in the transfer of the school?—I never heard of such interference.

6399. In your evening school is the instruction technical, that is to say, specially directed to trade processes?—Our instruction is entirely controlled by the syllabuses drawn up by the Department Examiners.

6400. Can you give the Commission some information as to the history of your mining school?—As I have already said, the school owed its origin to the late Mr. Mackworth, but he was assisted very considerably by Mr. Cossham. As I have also said before, Mr. Mackworth died when very young, and Mr. Cossham then became the only active supporter of the school.

6401. The operations of the mining school were suspended for some time, were they not?—No, they were never suspended, but the basis upon which the school worked was altogether altered. I should tell you that after Mr. Mackworth's death, the subscription list, which I referred to, fell off immediately. Then Mr. Cossham supported the school almost from his own pocket for a year or two, but that of course was a state of things which could not last. Mr. Cossham, I have no doubt, for the last two or three years of his connexion with the school, spent at least 100*l*. per annum upon it. I suggested over and over again to Mr. Cossham that an attempt should be made to give the school a self-supporting character, and at last he got tired, as one would have imagined, of spending so much money, and withdrew; but instead of allowing the school to fall we at once raised the scale of fees to what they now stand at. Previously the fee had been merely a nominal one, and yet the majority of the young people who had been educated with us were the sons of coal proprietors and people in that position. We have educated, it is true, a great many miners who have saved money to come there to educate themselves; but every one of the young men who studied

in our mining schools are now occupying positions of trust. I know none who are not occupying good positions in mining industry.

6402. What is the entire income of the mining school at present?—About 30*l*. The teacher in mining gives a lecture of one hour per day. His emoluments have been better, but at present all that he derives from the fees is 30*l*., and he will make some few pounds in the May examinations upon the examination in mining.

6403. What is the utmost that you can expect him to make upon that examination?—Say 5*l*.

6404. Are there no subscriptions?—None at all.

6405. Who is the teacher?—The teacher is Mr. William Morgans, who was formerly the sub-manager of the Brendon Hill iron mines.

6406. What other occupation does he follow?—That of consulting mining engineer.

6407. Is he resident in Bristol?—Yes.

6408. It is the fact, is it not, that in Somersetshire mining operations are carried on to some extent?—Yes, and in Gloucestershire also, more so in Gloucestershire I should say; but we draw the greater number of our pupils from South Wales. I think as far as the collieries are concerned, immediately around us, all those at present who wanted education have had education from us.

6409. What do you mean by "who wanted" it?—All the young people who are at all engaged in the management of mining enterprise in the neighbourhood of Bristol have been educated by us.

6410. Do you mean that the superintendents and overmen who have charge of those operations are generally well-qualified persons?—I am speaking more of the management of the mines, but very few of the overmen have had teaching from us.

6411. Do you mean that generally speaking the persons engaged in the management of mines in the immediate neighbourhood of Bristol are persons who have been educated in the Bristol Mining School?—Yes, I speak of those; we are but a young institution; we have only been in existence for 15 years. The older proprietors still manage their mines without any systematic education applied to their industry.

6412. But the pupils issuing from your school have obtained employment without difficulty?—Yes. We have seen this, that young men who come to us with really no practical knowledge of mining have at the close of their term with us obtained appointments in the management of mines. Of course it is a great evil that young men should be engaged in the practical working of mines who have never seen much of mining industry till they take a position in the mine, and it occurred to Mr. Morgans and myself to attempt to remedy this in this way: Mr. Morgans had an opportunity of taking a small pyrites set not a very great way from Bristol, and our thought was to employ our young men a portion of the time in working this pyrites set, and a portion of the time in the school. We intended to devote the summer months to the study of mining in the mine and to visiting other spots in which mining enterprise was going on, and to practical education in surveying; the winter to be devoted to the study of applied science in the school. I have here the prospectus of that enterprise, and we shall attempt to carry it out provided we keep Mr. Morgans with us, but at the present time he is solicited by a coalmaster to take the management of his colliery, and if Mr. Morgans leaves us to do that, the scheme will fall to the ground.

6413. You stated that the lectures in mining occupy one hour daily; what other classes do the young men attend in the mining school?—All the classes. Our mining lessons take place the first hour in the day during which we are engaged in work that is not scientific; the remainder of the day they pass with us in the Trade School.

6414. Are they resident in Bristol?—Yes. There are three pupils at present whose friends reside in Bristol, and there are three who come from a distance,



from different parts of South Wales, for the purpose of receiving our education.

6415. Have there been any proposals within your knowledge for the establishment of a mining school in South Wales or Monmouthshire?—Yes, several. At the last meeting but one of the South Wales Institute of Mining Engineers, I read a paper containing suggestions for the establishment of such an institution in South Wales.

6416. Has that led to any further steps?—The matter seemed to be taken up very warmly. It was at the invitation of the secretary of the association that I read this paper, having had some experience in mining schools. The President is the steward of the Marquis of Bute. The matter was taken up very warmly by that association, but whether steps will be taken to establish a mining school or not, I cannot say. With the permission of the Committee I beg leave to hand in the following prospectus:—

#### SCHOOL OF PRACTICAL MINING.

This school affords to those who seek to hold responsible positions in connexion with the management of mines that intimate acquaintance with mining operations which nothing but actual experience of underground work can supply, combined with such office practice as can be well acquired only in conjunction with experience of this character.

#### COURSES :

- (1.) Six months from the latter part of June each student will work with an experienced miner, from 8 a.m. until 4 p.m. daily (except Sundays), in a metalliferous mine, now being developed, which possesses several veins, and offers excellent mining practice. The students will take full part in everything connected with working and securing the ground under the various conditions involved in exploring and developing the veins.

Facilities will be given for the students to acquire some practice in ore dressing, and in sharpening and tempering their tools, as well as in executing any rough carpentry required at the mine.

Two evenings in each week, from 7 to 9 o'clock, will be set apart for lectures on branches of the art of mining, and for modelling in sand, &c.

Saturdays will be mainly devoted to a consideration of the most useful principles of ironwork, masonry, brickwork, and carpentry, and to designing mining buildings, and plant, the making of working drawings, and the framing specifications of ore and estimates for the same.

Occasionally, mines will be visited to enable students to become initiated into the repair of engines, boilers, and pumps, the setting of valves, examining pitwork, &c.

#### Vacation.—ONE MONTH AT CHRISTMAS.

- (2.) January, February, and part of March, the students will have laboratory practice at Bristol, chiefly assaying; and there will be lectures and instructions in the sciences as applied to mining. On Saturdays, in this term, various industrial establishments will be visited.

About one month from the middle of April will be devoted to mine surveying, with and without the needle, and to the preparation of plans and sections of different classes of mine workings.

It is considered that surveying can be properly mastered only by going through an uninterrupted course, and encountering obstacles as they arise, and not by selecting patches for a single day's practice periodically.

A period of from one month to six weeks, commencing in May, will terminate the course, and this will be employed in making mining excursions.

The foregoing courses will qualify each student properly to appreciate the systems and details presented to him under diverse conditions, and to book useful notes, and understand what is worthy of observation and enquiry during the excursions.

Portions of the time will be spent in Cornwall, Monmouthshire, Glamorgan, and North Wales.

Each student will be expected to draw up reports upon what he sees and hears.

#### INSTRUCTING STAFF :

Chemistry and Physical Sciences -	THOMAS COOMBER, F.C.S.
Mining Engineering and Surveying -	WILLIAM MORGANS.
Geometry and Machine Drawing -	R. KERNICK.
Mathematics -	JAMES WELSH.

T. Coomber,  
Esq.

9 March 1871.

#### FEE 100 GUINEAS IN ADVANCE.

The expenses of board and travelling will amount to about 80*l.* extra for each student. At the mine, board and accommodation can be provided for each student at 1*l.* per week, and at Bristol on the same terms.

Not more than six or eight students for the course can be efficiently trained, and arrangements will therefore not be made for a large number.

Any student can, if desired, be afforded an opportunity of having a few months' practice at coal cutting. This can be most advantageously entered upon after he has had the six months' practice in mining of the more general character.

Application to be made to the Secretary.

6417. (*Chairman.*) Do you know of any elementary school in your district in which a successful attempt is made to explain natural phenomena to children so as to give them habits of thoughtful observation and avoid common gross notions and superstitions?—No, I do not think so far as my knowledge goes that there is any attempt to teach science in any of the elementary schools surrounding us. Many of the masters of the elementary schools study science with us in our night classes, but that is with the object of becoming science teachers themselves; directly they acquire the requisite knowledge of science they move off to take posts in which their knowledge can be used as science teachers.

6418. You do not know of any master who teaches the nature of such natural phenomena as the clouds, rain, thunder and lightning, and similar phenomena?—No, I think that was previously done in elementary schools, but recent legislation has altered that.

6419. You remember the time when that was done with advantage?—Yes, I think so, but the rigorous devotion to elementary work, demanded by recent legislation, has made that a thing of the past in elementary schools.

6420. Is it your opinion, from your knowledge of children of that age, that scientific instruction of that kind might be introduced with advantage into elementary schools?—I think so to the extent I have already indicated in my answers to Professor Huxley's questions.

6421. Taking care at first in the training college that the master should receive sound scientific instruction and that with that he should be made conscious of the exceeding delicacy and care with which he should adapt his method to the tender age of his scholars?—Yes.

6422. (*Mr. Samuelson.*) Are you prepared to give any opinion as to the sufficiency of the test imposed by the Science and Art Department upon teachers as a qualification for earning payment on results?—As far as chemistry and physical science are concerned, I think it should be demanded on the part of those to be engaged in teaching both those subjects, that they should exhibit the power to handle the necessary tools and appliances, for chemistry is a handicraft, and a teacher who offers himself as an instructor in that subject should be made to exhibit some skill in his handicraft before a qualification is conceded to him. The same remark applies in a less degree to the teachers of experimental physics.

6423. Do you consider that that is essential?—I consider that no man can teach chemistry properly unless he is a fair chemical handicraftsman.

6424. Do you think it is possible by written papers to ascertain whether he possesses that qualification?—I do not think so. Professor Frankland is now examining rigorously in chemical analysis, which may be made a thing of book work. I do not mean to say that the examiner may not by a slip see that the man is no workman, but it is possible that paper after paper may pass without such a slip occurring.



T. Coomber  
Esq.

9 March 1871.

6425. (*Chairman.*) Is there anything else which you would like, having regard to the whole tenor of your examination, to communicate to the Commission? —With regard to the education at the School of Mines and the College of Chemistry, I think, in the first place, it would be a very great improvement to the teaching of the School of Mines if a professorship in mathematics were established. The assumption, I suppose, is that young men come to the School of Mines prepared with such an amount of elementary education in mathematics as will enable them to follow the teacher of mechanical physics; but as far as my observation went, the fact was otherwise. Moreover, as all the sciences applied to industry have a mathematical basis, it seems to me most essential that the teaching of mathematics should form a part of the curriculum of that school. A great want that I felt in the school was a little assistance in addition to that which is obtained from the lectures of the professors. I, as a practical teacher, find this, that even amongst my most clever boys, if I am to teach a thing soundly, it is a very line upon line and repeating business; and the want that I felt in that school was of the power of coming into contact with such a functionary as a professor's assistant, who would remove my difficulties and take a little pains to make the subjects that had been lectured upon clear to me. I have already spoken of the necessity of a physical science laboratory in my own school. This is, of course, a still more important necessity in this school. Lastly, the school has a very long vacation. This vacation may be necessary for men occupying professorial positions whose brains are taxed to the limit through the whole of their lecture session, but so long a vacation is not really necessary to the students, and I think it would be well if some such gentlemen as those functionaries who should be engaged in repeating and still further elucidating the work of the professors were engaged during a portion of the long vacation in accompanying those that were to be engaged in mining pursuits to the seats of mining industry, those to be engaged in manufactures, through the chemical manufactories of the country, and those to be engaged in engineering operations through the engineering works of the country.

6426. (*Professor Huxley.*) But the amount of vacation is only two months, and the examinations are taken at the end of July?—I think that a month at that time would be very profitably employed in the way I am suggesting. I think that a student will find himself fit for fresh work after a month's rest.

6427. Do not you think that the students would grumble very considerably at not getting more than a month's vacation in the whole year?—Not the right stamp of students.

6428. Do not you think that the professors would be rather sharp after having teaching from October to the July examination, and having then to begin da capo?—I am speaking now of appointing a staff of sub-professors who would undertake this work. I have recognised in what I have said that the professors of necessity must be worked out by the end of the session. With regard to the subject of the provision of mining schools, I would like to make this one additional remark, I do not think it is possible that a mining school can exist alone. I think that it must have some such institution as ours to lean upon. I think that the proprietors of mines, and those who wish for education for their sons in that direction, would be very willing to pay a fair fee for the technical education of their sons. As yet there is not sufficient demand for this sort of teaching to pay for a complete institution, but there is sufficient demand to pay and pay well for the education in mining, provided that this mining faculty could be affiliated to an institution which could provide the other work. That is to say, it would be impossible to ask fees from a mining student which should pay for the professors of chemistry, mathematics, experimental physics, and the other sciences which a mining engineer requires to study, but he could pay his fraction of the fees to those classes, and

in addition what was required to pay the master who would undertake to teach him mining. The same remark applies to provincial medical schools. I think it would be very much to the advantage of such schools if they could be affiliated to schools of a more general scientific character. In our medical school there are from 30 to 35 pupils, and the consequence is that when the fees from those pupils come to be divided amongst the staff of teachers in that school, the remuneration of the teachers is very small indeed. One can see at a glance that if this medical school were affiliated to a school of more general scientific education, the gentlemen who lecture at the science school could also, without very much additional trouble, take the students of the medical school, and for the same fees you would be enabled to obtain very much better teaching. There is in Bristol a society, the object of which is to sustain a very good museum, and attached to that now is a very good library. This society (I speak now of the society organised to sustain the museum) has been in a struggling state ever since I have been in Bristol. They have affiliated themselves to the library, because the library has been to a great degree a success. The gentlemen interested in the museum are gentlemen connected with both institutions, and they have therefore associated the two institutions to enable the library to sustain the museum. It may do this, but I think it is most likely that it will not, for I cannot conceive that a museum can continue to find support unless it be connected with a good school for the study of higher science. You see then that we have in our city of Bristol the two most expensive adjuncts of a high scientific school, namely, an excellent library, and a museum that is spoken of as being one of the best provincial museums. I should tell you that when one visits this museum, as a rule, one finds nobody there, but if a good provincial higher science school were established at Bristol, this museum and library would at once find their proper use, and most reliable support. There is therefore an excellent opportunity for forming a high science school in Bristol, in which medicine, commerce, engineering, manufactures, and mining should all find a place. I say they should all find a place, because much of the teaching would be common to each one of those pursuits, and consequently the cost of the professorial staff would be greatly economised by taking in such a range of subjects.

6429. (*Chairman.*) I understand you to mean that there should be chairs of pure scientific theory, and that there should likewise be connected with the institution the means of giving the technical application of pure science to those several industries and pursuits in life?—Yes. For example, the young men attached to every one of those pursuits will want courses of lessons in mathematics. If you attempt to form an engineering school you cannot get a good mathematical teacher, because you cannot give a man a sufficient consideration for his services; but when you have got mining, engineering, medicine, commerce and all to draw from, you bring into the school treasury an amount which will enable you to command the very best teaching in the market.

6430. You would hope to render pure scientific instruction accessible to a large body of students, and to obtain from them and other sources the means of remunerating at a higher rate more competent professors?—Exactly so.

6430a. (*Dr. Sharpey.*) Instead of having a teacher of chemistry and a teacher of mathematics, and so on, in each small department?—Exactly. Instead of having half a dozen scattered schools I would unite them to the advantage of every one.

6431. (*Mr. Samuelson.*) In what way could this Commission, in your opinion, contribute to bring about the establishment of such an institution as that of which you have spoken?—The Commission have heard my recommendation, and if, after reflection, the Commission could add their voice to my recommendation, I make no doubt it would have very great weight with the citizens of Bristol.



6431a. (*Chairman.*) Have you any hope that contributions would be obtained from the Corporation of Bristol or from public subscription or otherwise?—I think that there is an immense public spirit in this direction which could be without difficulty evoked. I have with me some papers that were drawn up partly by Canon Moseley and partly by myself upon the

The witness withdrew.

Captain J. F. D. DONNELLY, R.E., further examined.

6432. (*Mr. Samuelson.*) Will you state to the Commission whether there is any regulation of the Department with reference to the payment of fees by students of science classes in connexion with the Department?—The payment of fees by the pupils is not an absolute condition with respect to the grants for science instruction. The rule on the subject is to the following effect:—"The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though My Lords do not consider it necessary to lay down any rules making the payment of fees an absolute condition of the grants on account of science instruction, yet, as the payments from the state must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, committees of schools and classes and teachers are strongly urged (should it at present not be the practise) at once to impose as high a scale of fees as they consider can be raised, not only on middle-class students, but also on artisans."

6433. Will you have the kindness to state how long that warning has been before the conductors of science classes?—I think that warning has been inserted in the Science Directory ever since 1863 or 1864, I am not quite sure which, and we find that fees are paid—very fair fees for the artisan class, I think—in most of the old and well-established schools, and where the locality takes much interest in the matter, but in many of the other schools I am afraid there are no fees paid at all. The amount of the fees is shown in the appendix to the Science Report and in the Science Directory, in the last column of the List of Schools. There have also, I am afraid, been cases, though these are principally in Ireland, of arrangement between the teachers and the students by which the teacher agrees with the student that if he comes and learns and passes well, he shall receive a share of the money that the teacher receives on account of his instruction. It is not confined to Ireland. As far as we know, it prevails a great deal more in Ireland, but there are some few cases in England.

6434. Have you any means of knowing, with reference to particular schools or classes, what is the proportion of local contribution to the contribution by the state?—We have never had a return from the schools of the total amount received. We propose to get it in future, but we have not got it hitherto. They have only returned to us what fees they charge, and those are given against each school in the report. Several cases have come to the knowledge of the Department lately of the non-payment of fees, and also of this arrangement between the teacher and the pupil, and in consequence the Lords of the Committee of Council yesterday passed this minute:—"My Lords regret to observe the number of science schools in which no fees are charged, or in which they are merely nominal. The schools cannot be considered in a wholesome condition when students, a very large proportion of whom are adults in the receipt of wages, obtain their instruction wholly at the cost of the state, and without any pecuniary contribution on their part. Nor is it probable that they will value as they ought what is given gratuitously. The directions in the Science Directory are very plain on the point." Then they quote the rule which I have just read:—"My Lords would desire to call the serious attention of the committees of schools to this direction where fees are not imposed.

Trade School; also a Report of the Trade School for the year 1869; also the prospectus of the Mining School which is affiliated with us; also the prospectus of our day Trade School; and also the prospectus of the evening classes of the current session, which I hand in (*delivering in the same*).

T. Coomber,  
Esq.

9 March 1871.

Capt. J. F. D.  
Donnelly, R.E.

"They find that in some places not only is there an entire absence of fees, but that there has even been an unseemly competition on the part of teachers to get students by any means to join their classes with the view of earning the payments on results. They therefore give notice to the committees of schools that unless they themselves take steps to remedy the present evils by imposing at least some small fees which should be paid to the committee direct it will be necessary for My Lords to reduce the amount of the payments on results. My Lords have no wish to reduce the payments on results at present, and they would avoid as long as possible the imposition of new conditions, which necessarily complicate the system of aid, and render the rules burdensome and difficult to work under, but the want of proper vigilance on the part of the committees may render this step necessary."

6435. Does that apply to any large number of schools? I mean, in the first place, the absence of all fees?—No, I do not think it does to a large proportion of the schools.

6436. Is it possible always to distinguish fees which are paid in respect of scientific instruction from those which may be paid in respect of other advantages derived from mechanics' and other institutions?—No; the return is often rendered in the form that a contribution of so much, say 5s., or whatever the amount may be, covers the attendance at all the classes of the mechanics' institution and the library. I may say that the nonpayment of fees is a very bad thing, but it is very difficult to make any rule absolutely to prevent it. To make that clear I must go back to what one may call the original starting point of the system, which is that the promotion of science instruction, according to the plan which we have been compelled to adopt, depends entirely on appealing to private adventure. There was no local organisation nor any local interest which would have taken up the thing. The experiment was tried before the present plan was adopted, and it was found that you could never get any sufficient local aid to rely upon. The present plan has depended for development entirely upon enlisting private local adventure, and in order to get that private local adventure enlisted you have to bribe pretty highly. It has thus become worth the teacher's while to get up his class as best he can. Where classes have been established for some time, and where the locality has taken some interest in the matter, we find that fees have been paid, and are generally required. It is in small places where classes have been recently commenced, and in large towns, where there is much competition between teachers, that the fees have been remitted. I think we shall be able to a large extent to meet that rather unseemly competition amongst teachers in large towns by the aid of the School Boards. Up to the present time it has been impossible for the Department to say that such and such a class was an imposture, and that it must not exist; but where you can refer the question to a local body with local authority, such as the School Board, I think we shall in time be able to meet that difficulty very well. I do not think it would be advisable, even if possible, to impose an absolute condition that you should not make any grant unless the pupils paid fees, because where the teacher wished he could very easily evade it; he has only to get the fees and pay them back again; and you would be imposing a restriction upon all the good schools which would be very irritating. They would have to send up a form of certificate and have to take a great deal of unnecessary



Capt. J. F. D.  
Donnelly, R.E.

9 March 1871.

trouble, because of the bad schools. I think the only real way in which the Department can meet the difficulty will be to arm itself with strong power so as to be able at any time, if it be found that the fees are not being fairly paid or that any collusion is practised between the teacher and the pupil, to say that in future that teacher shall not be allowed to earn grants at all from the government. It must always be remembered that it is the teacher's interest to get as large a fee as he can out of the pupil.

6437. In those cases where no school boards were established, how would you proceed?—I think we must trust a good deal to inspection and to finding out where fees are not really paid, and then taking strong measures with the teacher.

6438. Is it not possible to insist upon there being only one committee in each town?—If you could form any basis for the committee, such as an election by the people, under rating or anything of that kind, it would be a very good plan, but where the committee is a purely voluntary body, formed no one knows how or on what principle, it would be impossible for the Department to say, "We will accept A B C as a committee, and not accept D E F as a committee," because the two committees may be equally good and may represent different interests. One may be a Roman Catholic committee to look after the Roman Catholic schools, and the other may be a committee to look after some other schools.

6439. Cannot you do this? Cannot you refuse to recognise in future a second committee in any town in which there is already one existing?—I do not think that would be at all possible. Classes may have commenced at a mechanics' institute, and a committee may have been formed to superintend those classes. If another rival institution, a Christian young men's association, or any other institution of that kind in the town wished to open classes, I do not think it would be possible for the Department to say that they should not have classes unless they chose to put them under the committee of a rival institution.

6440. You think it would not work well?—No, I think not.

6441. You now allow some small fee, do you not, to the secretary?—Yes, but it is a very small matter.

6442. You might withhold that, might you not, if you thought expedient?—Yes; but I do not think it would be at all just to prevent other classes being established and superintended by another committee. Sometimes appeals have been made to us to prevent them, but the utmost we have attempted to do is what, for instance, we did in the case recently of Plymouth. An inspector was directed to inquire into the circumstances on the spot, and in his report we wrote them a letter, asking them to agree among themselves to form one committee to look after all the science and art schools in the town. But the jealousy of the teachers was too strong for us, and though a majority of the committee were in favour of an amalgamation, after much consultation they preferred remaining as they were. After very careful consideration I believe the only thing that the Department really can do is to aid the local committees by such a minute as has been recently passed, and to take powers into its hands for dealing summarily with the teachers that do not take fees.

6443. You do not think that there is any plan of ensuring that fees shall be paid, and you are afraid that to insist upon the payment of fees would rather tend to promote collusion or to create collusion where it does not exist now, than to ensure their payment?—I think so. It would be imposing a very irritating and unnecessary condition on a very large number of schools.

6444. Could you obtain a return of the amounts actually paid?—Yes.

6445. Have you considered the question of removing the restriction upon payment by results which now limits it to artisan students?—Yes; it is a question which has been brought forward at various times since the aid to science instruction commenced, and has been brought forward again lately in consequence

of the New Code having omitted the clause which stated that payments were only made for the children of the labouring poor. The condition of payment now is that the school fee shall be less than 9d. a week, and two or three people have written to the Department to know, whether under the circumstances the conditions of the aid under the Science Directory will be altered. It would, of course, as far as the Department is concerned, be an enormous advantage to do away with the existing restriction. It would simplify the administration enormously. It would get rid of the present hard and fast line of 100*l.* a year income, which becomes very difficult to administer in some cases, and is often a great hardship. You have people just above and below the line between whose incomes there really is practically no difference, one of whom is aided by the state, and the other is not. The fact generally, I have no doubt, is, that it would be an enormous advantage if you could get rid of that or any other class restriction. But then comes the money question. If you simply opened the present system of aid under the Science Directory to all classes, the middle-class private adventure schools would take advantage of it to a large extent, and would earn very large payments. The payments in aid to science instruction would become very large, and it would be necessary to take measures to reduce them. You would gradually raise the standard for paying on results, and the end of it would be that the artisan class would be squeezed out altogether. It is much easier for a master to teach middle-class students, boys at school who have had greater opportunities of education, and are completely under his thumb, than to teach the artisan class whose primary instruction has been much neglected, and therefore I do not think that it would be advisable simply to erase that restriction with regard to the class on account of which payments are made from the Science Directory. I believe it would lead very soon to the artisan class getting no aid practically from state payment at all. At the same time I think there may be a way in which to make payments for all classes under some restrictions which would prevent any harm ensuing. Now that an alteration has been made with regard to elementary schools, I think that all teachers of pupils in elementary schools should, when they taught science in those elementary schools, receive state payment, whatever class the pupils belonged to. That would meet a limited class. I think, again, that where a town, by local rates had a really *bonâ fide* public institution at which all classes could receive science instruction at moderate fees, and all classes worked together, there, I think, you might do away with any restriction as to class. I think the principle on which those two exceptions might be made is that they were not private adventure schools, but that they were local public institutions supported by local rates, to which all the classes in the locality contributed.

6446. Would you confine it to institutions supported by local rates, or would you admit institutions supported by local subscriptions?—Perhaps under some restrictions you might extend this benefit to institutions largely supported by local contributions as well, but it is very difficult to say, speaking off hand. We have never had the case absolutely brought before us to frame rules, and it would have to be done with very great care.

6447. But you would admit the principle?—Yes, I think so, so long as you could exclude the class of private adventure schools and institutions which are conducted for private gain only. But it would have to be done with very great care, and the case is not so clear as with rates, by any means.

6448. But which you now admit so far as the artisan class are concerned?—Yes, I would continue our present rules with regard to all this class of institutions, that is to say, paying on the artisan only, but I think where you had what was a *bonâ fide* public institution, admitting all classes at a small fee, you might do away with the restriction as to the class



of person on whom the government payments were made.

6449. Would you go on a step further or not, and prohibit the establishment of private adventure classes in future?—No, certainly not. I do not think that we are at all ripe for that as yet. I think that the country has to be prepared by those private adventure classes for several years before the localities will take anything like sufficient interest in the matter to enable you to look to public institutions only.

6450. You, of course, have taken into account the fact that the change in the Revised Code to which you have called attention has arisen partly at least out of the change in the rule which compels localities to provide schools if necessary at the expense of the rates?—Yes.

6451. But I believe that the restriction also existed with reference to evening schools, but that has now been abolished, and yet the establishment of evening schools is not incumbent upon the localities?—No, but the evening school is restricted to adults, and the government payments made for them are very small in amount. It would not be possible for a middle-class private adventure school to take advantage of those grants, nor would it care to take advantage of them. They would, however, immediately take advantage of the government grants for science instruction, and would earn very large payments under them.

6452. Supposing your regulations were so modified as to give small payments upon results, a very much smaller payment than that which is given now in respect of elementary classes, which should be open to all, and that your higher payment should be reserved for much more systematic instruction, how would that work?—I am afraid that our present payments for our present grade of elementary instruction are already at the lowest point that they can well be put, compatibly with encouraging scientific instruction amongst the artisan class. After a few years, when there is really a demand for science instruction, it is to be hoped, and it is quite possible, that you will be able to diminish the state payments in amount, and you may look to graduated fees on the part of pupils, the artisan pupil paying a smaller fee than the middle-class pupil, but I do not think that we are ripe at the present moment for reducing the payment on account of elementary science instruction, without very materially checking the increase of that instruction.

6453. You say that this question of the abolition of class distinction has been urged for some time; do you mean that it has been urged from without before the late change in the Revised Code, or that it has been a matter of consideration within the Department?—It has been urged from without, and in consequence of that it has been talked about more or less; not brought officially before the Lord President or the Vice-President for the time being, but it has rather come up casually, and has been casually discussed.

6454. Would you like to put your views on the subject more definitely into shape and submit them to the Commission?—I should be happy to do so if the Commission thought it of any advantage to them.

6455. Have the applications from the country been numerous on that subject?—No, I do not think they have been numerous. I think they have generally originated by committees writing to us that they had great difficulty in complying with our rules; that it became very invidious for them to inquire into every student's status, especially where they were not really artisans and not earning weekly wages. Those cases in which the student is earning weekly wages are very easily settled, but when committees have to inquire into the pecuniary position of clerks and shopkeepers, perhaps a dissenting minister, or people of that class, who were just about the line of 100*l.* a year, it becomes very invidious and very difficult for them.

6456. Is the line of 100*l.* a year stated in the form of a minute, or is that the interpretation of the officers of the Department?—No, it is formally laid down under Rule 36:—"Payments are made to the qualified

"teacher on account of the instruction of students of "industrial classes only." Then the interpretation of that goes on: "Under 'students of the industrial 'classes' are included artisans or operatives in the "receipt of weekly wages, coastguards, policemen, "and others who, though in receipt of weekly wages, "do not support themselves by manual labour; teachers "of elementary schools in connexion with the Educa- "tion Department, Whitehall, or the National Board of "Education, Ireland; persons in the receipt of salaries "not large enough to render them liable to the income "tax, as some descriptions of clerks, shopmen, &c.; "small shopkeepers employing no one but members of "their own family, and not assessed to the income tax; "tradesmen and manufacturers on their own account, "supporting themselves by their own manual labour, "not employing apprentices, journeymen, &c., and not "assessed to the income tax; the children (not gain- "ing their own livelihood) of all such persons above "mentioned; and no payments are made on account "of any other students." The line is really whether they are liable to income tax or not.

6457. Have you considered the possibility of giving instruction in elementary science in such elementary schools as are subject to the action of the Whitehall Department?—It is proposed to provide for a certain amount of elementary scientific instruction in the Code which is now on the table of the House, but not finally approved. In some elementary branches of science I believe it would be quite possible over and above that, to have in many schools an advanced class with scientific instruction reaching as far as is required in the syllabus of the Science Directory. I believe in large towns it would be better not to have those classes in the elementary school, but to draft off the boys to a secondary school; but in small towns and in country districts where you could not have those secondary schools, I see no difficulty in having advanced classes for science instruction under the provisions of the Science Directory by an arrangement between the two Departments. It is now done to a certain extent by evening classes in those elementary schools.

6458. I believe that the recent Revised Code provides that payment is not to be made by Whitehall to those pupils who receive payment from South Kensington?—Yes, as for instance, physical geography is one of the special subjects mentioned under Article 21 of the Code, the Sixth Standard; and physical geography is one of the subjects of the Science Directory. If a pupil passed in that subject under the Science and Art Department, and his teacher received payment on account of him, the teacher of the elementary school is not also to receive payment for the more elementary branch of physical geography that he had been taught in the elementary school.

6459. Then the result of that will be that a school-master can present a pupil either to his inspector or to the Science and Art Department for examination, according to the course which may appear to him to be productive of the greatest emolument?—What he would probably do would be to present him one year under the Education Department of Whitehall, and then afterwards, when he was more advanced, he would present him under the Science and Art Department. Under a school board they may organise their schools, as I understand, and either have advanced classes, which will bring them under the Science and Art Department, or they may organise their schools so as to remove their upper pupils and put them into a secondary school, and that is what I hope will be done. It is what we have often recommended, and what I believe they are attempting to do at Bristol now.

6460. (*Chairman.*) What then would you conceive to be the age at which a boy could—besides what the Education Department require up to the Sixth Standard—acquire such higher instruction as would satisfy the Science and Art Department?—I think the best answer to that question is a table which I put in the last time I was examined as to the ages of successful students and the per-centages of those who succeeded. It begins at eight; there is a very small per-centage at eight,

*Capt. J. F. D. Donnelly, R.E.*

9 March 1871.



Capt. J. F. D.  
Donnelly, R.E.  
9 March 1871.

but at 12 and 13 there is a very fair per-centage. A very fair per-centage of the boys in a school, one may consider, would pass the Fifth Standard by their 11th year without any very great difficulty, and they might remain till they were 13 years of age. Those boys who have already passed that standard might be learning science, and as a fact do so sufficiently to pass in a branch of science; it is a fact that a large per-centage do pass every year.

6461. (*Mr. Samuelson.*) My questions were rather aimed at the point of administration. Are the subjects in which the pupils may be presented under the new Revised Code limited, or may they cover the same ground as the syllabus of the Science and Art Department?—Physical Geography, Mathematics, Physiology, French, German, and Latin are the specific subjects mentioned, but any other definite subjects of instruction may be taken.

6462. Then the Whitehall inspectors of course would be required to be competent to examine in those subjects in the elementary schools, if those subjects may be presented under the Sixth Standard?—I do not at the present moment know how they exactly propose to arrange that, but there would be no difficulty in having papers sent for the inspector to use in his examinations.

6463. You mean that instead of being examined in the usual way by the inspector locally, the pupil might be presented through South Kensington?—Much upon the same plan as we do, only that instead of our examination, which is simultaneous over the whole kingdom, the inspector would give a paper, and see it worked at the same time that he was examining the rest of the school. There would be no difficulty in arranging with regard to these papers, because they only take a very elementary portion of the subject, and you might have a larger number of questions covering, in fact, the whole subject of which the inspector would give a certain number at the time that he was examining the rest of the school.

6464. Have you considered the question whether the examination in those subjects might lead to some closer connexion between the two Departments?—I think so, certainly. I think that we are gradually working together in carrying out this plan.

6465. That is to say, that your Department may be rendered useful to Whitehall?—Yes.

6466. But has the converse occurred to you that the Whitehall inspectors might render essential service to ensure the good working of the scheme of the Science and Art Department?—I think they might.

6467. Have you considered that question at all in detail?—I feel convinced that the officers of the one branch of the Department may with great advantage assist the other branch of the Department in carrying out the administration.

6468. Supposing that a certain amount of laboratory work were demanded in certain branches in which payment is now made on results by the Science and Art Department, do you think that the Whitehall inspectors might be useful to you in reference to that?—I do not suppose that an inspector whose education has not included any scientific instruction, could be of much use generally with regard to laboratory instruction. But supposing you are obliged to use that kind of inspection you may very well do this. The Government may lay it down that the laboratory must be provided with this, that, and the other, and with a very little trouble the lay inspector could see that those absolute conditions are complied with; but of course the best way for meeting technical inspection of that kind would be to have technical inspectors.

6469. Do you attach any great value in reference to that part of their work to the labours of your present inspectors?—Yes. I think that that portion of the work is very satisfactorily done. I do not mean to say that if you had a very able man to go down and give advice, he would not do a great deal of good, but of course in that matter, as in all others, you have to count the cost, and consider whether the cost of send-

ing a very able man, and paying for him to go and inspect one class here, or another class in another part of the country, and give his advice, would repay itself. I think that as the system increases it would be essential to have, as it were, an enlargement of the examining system. That is to say, instead of the work of the professional examiner being confined, as it is now, to looking over papers at one period of the year, he or his assistants should go and visit the institutions, and give scientific and technical advice on special subjects. I think that is what we must look forward to. At the present time, if you carried that out to any great extent, the cost of administration would so much exceed the payments on results that there would be such an outcry that we should have to curtail it.

6470. But as the classes increased in numbers that cost would necessarily increase also?—Yes, in one way it would; but on the other hand, we must expect to have in the larger towns well-organised institutions for giving scientific instruction, and the comparative cost of a man going to Manchester and one or two places, large centres, and seeing about their organisation for scientific instruction, as compared with the whole amount of work done would be much less than if he had to run about the country, to look after a little class here of 10 or 12 students, and another class there of 10 or 12 students.

6471. Then you would contemplate this systematic inspection as being applicable only to the more important institutions?—Yes, not from year to year, but at longer intervals. The administrative inspection must, of course, take place every year.

If I may be allowed, now that I have the details, to revert to a question which was asked me just now, with regard to the ages at which students can study science with any advantage, I would remark that of those who were 8 years of age, 17 per cent. passed in some subject of science or other. Of those who were 9 years old, 23.9 per cent. passed, 10 years 29 per cent., 11 years 30 per cent., 12 years 34.6 per cent., 13 years 38.7 per cent., and 14 years 44 per cent.

6472. (*Chairman.*) Are those in elementary schools?—Those are the ages of students who have been presented, and who have passed in the science classes.

6473. Have the teachers been paid for those students who passed at those ages?—I cannot be sure that they have been paid on all of them, because we are not quite certain as to the class of persons that they were, but I should think that a large per-centage of them must have been paid on. There are only 29 persons who are over 8 years of age, 142 over 9 years of age, 599 over 10 years of age, 1,397 over 11 years of age, 2,572 over 12 years of age, and 3,007 over 13 years of age.

6474. Was the writing and spelling of those students such as would have enabled them to pass the Fourth Standard of the Code?—I should think so, certainly.

6475. I mean those students under 11?—I do not think that there would be a chance of their doing sufficiently well in an examination unless they could have satisfied the fourth standard, because they have to answer a fair proportion of questions in a limited amount of time. I have never looked over a number of papers of that standard, and therefore I am not able to answer precisely.

6476. (*Professor Huxley.*) Might not the effect of the science teaching which exists in the country in connexion with the Department of Science and Art be greatly improved and increased by making the teaching more systematic than it is at present, that is to say, by organising science schools in which the pupil should go through a regular course of instruction, say a two years' course of instruction, taking up one group of subjects the first year, and a second in the second year, and in that case would there be any difficulty in paying a master upon teaching of that kind to the same extent as he is paid now?—I believe that the systematic instruction would really



pay the teachers better, but at the present moment the number of what you may call secondary schools, where boys are learning science, is very limited. A large proportion of the people who come up are adults, as you may see by this table, who are taught in the evening classes, and with them it would be impossible to impose any restriction of that kind, at all events, at the present time. They come to learn what they think they want to learn, and what they choose, and if you were to say that they should not learn chemistry till they had learned something else they would probably not come to learn chemistry. I believe in the other classes, for instance, in a few secondary schools, there is a very fairly definite course of instruction, as for instance, in the Bristol school, and in the schools lately started at Worcester and Cardiff, and one or two places of that kind, they are organising it, and as we go on I think that one of the primary steps that we shall have to take will be to try and organise this system of instruction rather more than is the case at the present time.

6477. (*Mr. Samuelson.*) How many such schools are there which are analogous to the Bristol Trade School at this time?—Very few of them absolutely as large as that school, but there are a great number now where boys in a day school are taught science, and where they are giving them a fair course of instruction, as, for instance, Mr. Howard's School, at Islington, where they are taught during the day.

6478. (*Professor Huxley.*) Supposing, as we hear on all sides, and as is obvious on the face of it, there is a defect in the existing scientific teaching from the want of practical laboratory instruction, and supposing that in any town it were arranged that instruction should be given in a systematic way, accompanied by practical instruction in the laboratory, could a practical examination be instituted of the students at the end of each session, and would payments be made upon that kind of instruction adequate to the cost and value of the instruction; could you do that now under the existing regulations of the Department?—No; there is no existing regulation by which you can send down and examine people in absolute laboratory instruction and give them payments on that work. It is attempted to be met by the recent minutes for aiding laboratory instruction in chemistry.

6479. But there is no means of actually examining in that laboratory work at present, as I understand?—No further than by questions. I believe that the questions may be so framed that a boy would not be able to answer the questions unless he had gone practically into the laboratory instruction in chemistry, but at the same time there is no provision at the present time for absolutely watching him doing his manipulation and examining him in the absolute manipulative process.

6480. But supposing it to be extremely desirable that a boy should be put through an actual practical examination, not a very long one, but a *vivâ voce* practical examination, in addition to a written examination, in order to secure real results from the money which is spent in this way, would the Department be able of its own mere motion to organise an examination of that kind?—Yes. I do not know how far the

Treasury might check us, but the Lord President and the Vice-President could pass a minute arranging for that. You must at the same time again count the cost. You would have to pay a good deal for it. The great difficulty that you have to contend against is that the cost of administration shall not take away an overwhelming proportion of the grant.

6481. Do you think that the cost of conducting an examination of the kind to which I refer, which after all would be a very simple affair, would be so very great in the case of a considerable school, seeing that you do away with the expense of the other mode of examination?—It would come to a good deal. Of course if you restrict it to very large schools, of which I am afraid we have very few at the present moment, it would not come to so much in proportion, and I have no doubt that as schools grow, and you get large schools, this would come in under the plan I was speaking of, of the examiner or his assistant going to see some of the large schools and examining them on the spot.

6482. (*Dr. Sharpey.*) When you speak of rendering the instruction more systematic, conducting it in a certain order, and spreading it over a certain time, would that apply to independent teachers, or to an organised school?—I think that with regard to the evening classes it will always remain as it is now, rather casual; but with regard to the secondary schools, which I think will be more largely established than they have been hitherto, there the instruction may be on a definite and systematic plan.

6483. In a moderate sized town would there be one such school or several?—A comparatively small town would be able, one would think, to afford one hundred or a couple of hundred students of from 12 to 15 years of age.

6484. Would those be not scattered, but brought together into one school?—Yes.

6485. And there would be the more reason for that if they are to go through that practical instruction which has been spoken of?—Yes.

6486. (*Chairman.*) Is there anything else that you would like to state to the Commission?—With regard to this point of the secondary schools, it is already to a certain extent encouraged and provided for by a system of elementary schools' scholarships by which, if a locality subscribes 5*l.*, the Department gives 5*l.* towards the support of a deserving student for one year. Then there are the science and art scholarships, in which 10*l.* is given by the Department, the contribution of the locality being the same, to maintain the student for one year more while he is learning science. There is no restriction at present in force, but it would in time be possible to impose a definite course of instruction upon the scholars who are aided, and that would meet to a large extent Professor Huxley's view. But of course all these restrictions and impositions have to be done very carefully, the opportunities of getting any instruction at all are so limited that we have to be very careful.

6487. (*Mr. Samuelson.*) How are those science and art scholarships working?—They are working exceedingly well.

The witness withdrew.

Adjourned to Monday next, at half-past 11 o'clock.

Capt. J. F. D.  
Donnelly, R.E.

9 March 1871.



6, Old Palace Yard, Westminster, Monday, 13th March 1871.

PRESENT :

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, BART., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.

JOHN WINTER JONES, Esq., F.S.A., examined.

6488. (*Chairman.*) What is your office in the British Museum?—I am Principal Librarian, and by virtue of my office of Principal Librarian I am also Secretary.

6489. Will you describe the duties of the Principal Librarian with respect to the collections of the Museum?—The care and custody of all the collections being vested in the Principal Librarian by the Act of Incorporation, he exercises a general control over all the departments. If the Commissioners will permit me I will read from the statutes what the duties of the Principal Librarian are:—(1.) "To be responsible for the safety of the Museum and of the property and collections therein, and to give orders in case of fire or other accidents.—(2.) To exercise a general superintendence over all the departments, and to take care that the officers, assistants, attendants, and servants be regular in their attendance and perform their proper duties, and to report every omission in this respect to the Standing Committee. (3.) To make such remarks on the reports of the officers as he may think proper for the information of the Trustees; and at the foot of each of the Annual Reports of the Officers, to state his opinion as to the efficiency of their service during the year. (4.) To grant admission into the Museum to persons of eminence, either for learning or rank, especially foreigners, desiring to inspect the collections, but not able, conveniently, to avail themselves of the usual mode of admission. (5.) To take care that the Museum be kept open during the appointed hours, and that due order and propriety of behaviour be observed by all persons, whether visitors or others. (6.) To grant admission into the reading room, and to provide that such facilities be afforded to the readers as are consistent with the security and preservation of the collections."—Subsequently to the making of these statutes the Principal Librarian was also empowered to grant admission to the Departments of Natural History, to the Print Room, and to the Sculpture Galleries.—(7.) "To communicate to the officers and others the orders of the Trustees, and to see that they be duly carried into effect. (8.) To be the editor of the synopsis, to see that it be prepared and printed in a proper manner, and in accordance with such directions as may from time to time be given to him by the Standing Committee, and to take care that a sufficient supply of copies be always ready to meet the public demand. (9.) To be in attendance when the Museum shall be visited by the Sovereign, or by any of the Royal Family, or by Royal Personages of other countries." Then there are other duties connected with my office of Secretary, but which have no special reference to the collections.

6490. When was the British Museum established?—It was founded in the year 1753 by the Act of the 26th of George the Second, chapter 22, and was opened for public use in the year 1759.

6491. Will you describe the mode of its administration and government?—The affairs of the museum are administered generally by a body of Trustees, of which I have here a list. They are 50 in number, 25 of them are Official Trustees, comprising the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons, with whom rests the appointment to all offices in the museum except that of the Principal Librarian, who is appointed by the Crown. The other Official Trustees are the Chief Officers of State, also the President of the Royal Society, the President of the Royal College of Physicians, the President of the Society of Antiquaries, and the Presi-

dent of the Royal Academy. Then, there is a Trustee appointed by Her Majesty, to represent the noble gift of what is called the King's Library, and other valuable donations of the Crown. There are also nine Family Trustees; and all these Trustees elect 15 others, who are selected on account of high intellectual power or for their eminence in science, in literature, or in art. From this body a Standing Committee is selected, consisting of 15 members and the three principal Trustees, making 18 altogether. This Standing Committee is chosen by the general body of Trustees. The Standing Committee themselves select both from their own body and from the general body Sub-Committees on Buildings, on Finance, on Printed Books and Manuscripts, on Natural History, on Antiquities, and on Prints and Drawings. There is also a special Sub-Committee on the catalogue of coins and medals, and another to superintend the publication of the Greek inscriptions. In fact, when any matter of very special importance arises, the Trustees generally appoint a special Sub-Committee to conduct that business.

6492. Into how many departments were the collections of the British Museum divided when it was first established?—It was divided into three departments. At the time when the British Museum was established the Library was the principal feature, consisting of the collections of Sir Hans Sloane, the Cotton and Harley Collections of manuscripts and others, and the consequence was that the chief officer was called the Principal Librarian, and all the other officers, whether they had to attend to books or to manuscripts, or to natural history, were called Under-Librarians, but at that time the Museum was divided into three departments—Manuscripts, Printed Books, and Natural History, and no more.

6493. Do the Natural History collections now form one department?—No, they are now divided into four, in consequence of the general increase in the collections. Sir Joseph Banks died in 1820, and he bequeathed his library and his collections of botany to Mr. Robert Brown, the celebrated botanist, for his life. And after his death these collections were to come to the Museum. The Trustees in 1827 made an arrangement that the collections and the library should come at once to the Museum, Mr. Robert Brown being appointed Keeper of them, and receiving a salary from the Trustees. In 1837 a department of Geology and Mineralogy was formed, making thus three departments of Natural History, and in 1857 a department of Mineralogy was formed, making now four departments of Natural History.

6494. Is there any special superintendence over the Natural History Departments?—In 1856, when Sir Henry Ellis resigned the office of Principal Librarian, it was thought to be a good opportunity for giving effect to a recommendation which was made by the Royal Commissioners in 1850, namely, that the Natural History Departments should be placed under a Superintendent, and Professor Owen was selected to be that Superintendent. His duties are also set out in the statutes. He is "(1.) To exercise a general superintendence over the Departments of Natural History; (2.) to transmit to the Principal Librarian the reports of the Keepers of each department, accompanied by such remarks as he may think proper for the information of the Standing Committee; to suggest such improvements as, in his judgment, may increase the scientific value and general utility of the collections; and within the first fortnight after Christmas of every year, to lay before the Standing Committee an annual report on the condition of the collections

J. W. Jones,  
Esq., F.S.A.

13 March 1871.



“under his superintendence. (2.) To be the editor of such catalogues and other scientific publications as shall be entrusted to him by the Standing Committee; and to see that they are prepared and printed in a proper manner, and in accordance with such directions as may, from time to time, be given to him by the Standing Committee. (3.) To take care that the officers, assistants, attendants, and servants of each department be regular in their attendance and perform their proper duties; and to report every omission in this respect to the Principal Librarian.” Those are the duties of the Superintendent.

6495. From what sources are the collections increased?—They are increased by purchase, by donations, sometimes by bequests, and also by exchanges. Duplicate objects, particularly in the Natural History Departments, are frequently exchanged for other objects which are desiderata.

6496. Will you describe the duties of the officers of the Natural History Department?—Their duty is first, of course, to attend to the increase of their collections in the way that I have described, and then they have to register, to classify, and to arrange their collections, and also to display them, as far as practicable, in order that they may be useful, not only to the students, but also for the amusement of the public, who may visit them on the days when the Museum is open for public inspection; and they also have to publish such catalogues as may be ordered by the Standing Committee, or as may be suggested by themselves. The Commission, probably, may be aware that the Trustees have for a long time been publishing a very interesting series of catalogues on Natural History, a list of which I have with me here, and which I beg leave to hand in.

6497. Is there anything like a *catalogue raisonnée* of the Natural History Department?—No; there is nothing of that kind. It would have to be a fusion of separate catalogues of the different branches and subdivisions, which is a very wide range indeed. It would be a laborious undertaking to make a *catalogue raisonnée* of the general collections. Of course there are general descriptions which are issued to the public.

6498. How are persons admitted to the Natural History collections for the purpose of study?—They are admitted by application to the Principal Librarian, when the object is continuous study, and a person wishes to come frequently and to have the cases opened in order that the objects may be taken out and submitted to him: the Trustees consider that, under such circumstances, it is right that the student should come recommended in the same way as to the reading-room. But, in addition to this formal admission, a student has every facility, if he wishes to consult the collections for a temporary purpose; he has only to apply to a keeper, or to an assistant-keeper, or to some one known in the department, and no hesitation is made in giving him admission.

6499. During how many days is the Museum opened for public inspection?—It is open during the winter months, as a general rule, on Monday, Wednesday, and Friday, three days in the week; and during the summer months, that is, May, June, July, and August, it is open on Saturdays from 12 o'clock until 6. Then, I should also say that in the case of foreigners going abroad, or of persons going into the country, in fact whenever there is any special reason given, persons are always admitted to see the collections, on application to the Principal Librarian, so that practically there is no exclusion, so far as such persons are concerned.

6500. On how many days is the Museum open to students?—It is open regularly on two days in the week, Tuesdays and Thursdays, which are specially set apart for the use of students; but, as I said before, on other days, even on public days, if the students wish to consult the collections for any special or single object, facilities are always given. Of course I am speaking now only of the Natural History collections.

6501. Have any steps been recently taken for giving more frequent opportunities of access to the collections

for the purposes of study at other than the regulated times?—Last year an application was made from the secretary of the Working Men's Club and Institute Union for permission to visit the collections on Saturdays, when the Museum was not open to the public. The Trustees very readily granted the application, and many visits were paid, about 50 men came at a time. In the first instance they came accompanied by a gentleman who was competent to explain the Egyptian antiquities to them, but since that time they have generally been received by the officers of the Museum, Dr. Birch, Professor Owen, Mr. Waterhouse, Mr. Woodward, and last Saturday afternoon by Mr. Newton. In fact all are very ready to lecture on the collections whenever these men come, and it seems to give very general satisfaction.

6502. Have the Trustees power to part with or exchange their collections?—They have power to sell or exchange duplicates, and by an Act of Parliament which was passed in the 47th of George III., they have power to sell or part with things which are considered as unfit, but that is a very vague term, and I am not aware that that power has ever been exercised; but they have power to sell and exchange duplicates, and that power they have exercised on more than one occasion. In fact, as far as Natural History objects are concerned, they exercise it very frequently.

6503. Do the officers of the Natural History collections give any lectures upon them?—They have only explained the objects to persons coming in the way that I have mentioned, but they do not give lectures as a part of their duty. I have a very strong opinion upon that point myself, and I believe the officers themselves feel that it would be utterly impossible for them to do their duty as curators of the museum, that is to say, to make purchases, to draw up careful registers, to arrange the collections and superintend the catalogues, to do everything in fact which is necessary for students and the public, and to give popular lectures upon branches of Natural History besides. It would be quite incompatible with their duties—they could not do both things.

6504. Have you any suggestions to make to the Commission by which the usefulness of the Museum might be extended, as, for example, by allotting duplicates to provincial collections, or by any other means?—That is a subject which is now under consideration by the Trustees in consequence of a question which was asked by Sir Dominic Corrigan in the House of Commons the other night. I believe that there is a most mistaken impression abroad as to the extent of our duplicates. Persons think that we have a vast number of them, but the fact is not so. Our space is so limited that every care is taken not to acquire duplicates. There may be some duplicates from the old collections, but many of these are not in a good state. We have just sent out some to Australia in exchange for a very remarkable animal between a fish and a reptile which has been sent over to us, and when they were packed up Dr. Günther said he was almost ashamed to send them, and that is the case with a great number of our duplicates. We require some to supply the place of specimens which become injured by time—especially birds. There is a maggot which gets under the plume and gradually destroys it, and then we require to draw upon such store as we have of duplicates, in order to supply that damaged specimen. We also find that, having a few duplicates, we can sometimes make advantageous exchanges. In fact they constitute a part of our funds, and I think it would not be desirable to part with any of them for the purpose which has been proposed; certainly not to send away our collections, to have them fitted up, and to circulate them in the provinces, and then have them brought back as we want them, because I believe all naturalists will admit that specimens so treated become deteriorated, and ours might be no longer fit for the purposes of the Museum. It is of course a question for the Trustees and the Government, but that is the opinion which I myself entertain upon the subject.

6505. As the officers of the Natural History col-

J. W. Jones,  
Esq., F.S.A.

13 March 1871



J. W. Jones,  
Esq., F.S.A.

13 March 1871.

lections of the Museum would find it quite inconsistent with the duties which they have at present to discharge to give any lectures upon the collections, have you any suggestion to make to the Commission, or any opinion as to the advisability of such lectures, and the mode in which that function, if it be advisable, could be discharged?—The only way in which I think anything approaching to lectures could be given to advantage is that which I have just described, that a convenient number of persons, 40 or 50, should visit the Museum, one department at a time, and that the officer in the department should explain the objects before them. That is much more easy than to prepare a formal lecture with diagrams, without which the lecture would be unintelligible. It could be done with great ease in the way I have mentioned. Several visits have been paid and the men seem extremely pleased, and I believe the Secretary to the Union which I have mentioned means to propose a prize for those who produce the best notes of the lecture which Mr. Newton delivered on Saturday. I call it a lecture, but in fact it is an explanation of the objects, which is a very different thing. It involves only occasional reference to first principles; people can see the thing before them, and they can understand it better. Any officer of the Museum would be able without preparation to explain the objects under his charge. It is what Professor Owen and Mr. Woodward and others have done, and I think that it is a very serviceable thing to do, and ought to be encouraged, and the Trustees are very anxious to encourage it.

6506. Your impression is that great interest has been evinced in such explanations of the objects in the Museum, and that considerable advantage is likely to be derived from them?—I think so. I think it gives men a most intelligent interest in what they see, much more so than by going to a theatre and hearing a lecture, and then being sent into galleries filled with collections of Natural History where they are perfectly at sea, and do not know whether it is this object or that which they have been hearing about.

6507. (*Professor Huxley.*) The Sub-Committee on Natural History is, I think, composed of the Duke of Argyll, Earl Cadogan, Viscount Eversley, the Bishop of Winchester, Sir Philip Egerton, Sir Roderick Murchison, Sir Edward Sabine, Sir James Alderson, and George Annesley, Esq.?—Yes.

6508. What are the relations between that Sub-Committee of Natural History and the Superintendent of the Natural History Departments?—There are no special relations. He, like any other officer, would be questioned on any point upon which the Trustees or the Sub-Committee required information, and not only Professor Owen, the Superintendent, but also the heads of the departments concerned in the question before the Sub-Committee would be questioned.

6509. So that if it were a question concerning the Keeper of the Department of Zoology, we will say, the Sub-Committee would send for him directly?—They would send for Dr. Gray, and if they were not satisfied with the information which they obtained from him, they would then send for Professor Owen.

6510. The Sub-Committee on Natural History, as I understand, gives no orders of its own?—No.

6511. But it reports to the Standing Committee?—The result of their deliberations is sent to the Standing Committee as a recommendation.

6512. If the Standing Committee adopts that recommendation, how is it carried out?—It is embodied in a minute which I have to draw up by order of the Trustees, and then I communicate it to the head of the department concerned, and also to Professor Owen. I ought to say that whatever communication I make to the head of either of the departments of Natural History by order of the Trustees, I also send to Professor Owen. He has a copy of every communication.

6513. But it does not go through him?—No, it does not go through him; it goes direct to the officer concerned, and another copy goes to him; but all reports from the heads of the Natural History Departments come to me through Professor Owen.

6514. So that the orders of the Standing Committee go from you direct to the officers?—That is so.

6515. Mr. Owen being simply informed of it?—Yes.

6516. While on the other hand the reports of the officers do not come directly to you, but go through Professor Owen?—Exactly so. If they were to send me a report direct, I should immediately send it to Professor Owen.

6517. Has Professor Owen, as Superintendent, the power of remitting a report if he does not like it to the Keeper of the Department?—It is his duty to examine the report to see if he approve of it, and he has to write at the foot of it his approval or disapproval. He can communicate with the Keeper directly, with a view to inducing him to remodel his report, or he may send it on with any observation he may judge proper to say that he does not approve of it.

6518. Do you know whether the Superintendent may refuse to pass any report altogether?—The case has never arisen, but I should say it is not competent to him to do so. I should no doubt hear from the Keeper of the Department that he had sent such a report, and then I should communicate with Professor Owen, and ask him to give me his reason for refusing to pass it on.

6519. You consider, as a matter of discipline, that he has not the power to refuse to send on a report?—I do. He is directed by the statutes to transmit to the Principal Librarian the reports of the Keepers of each Department, accompanied by such remarks as he may think proper for the information of the Standing Committee, and therefore any objection he might have to the contents of a report could be conveyed in his remarks.

6520. In defining the nature of the office of Superintendent, is it not a part of his duty to edit catalogues?—Yes, such catalogues as the Standing Committee may entrust to him.

6521. But, as a matter of fact, have any of the catalogues which you have in the list been edited by the Superintendent?—They all have gone or they ought all to have gone through his hands. They are not all prepared by the officers in the departments of Natural History, but most usually it would be the Keepers who prepare the catalogues, particularly if they relate to some speciality of their own, but the manuscript when prepared is sent to Professor Owen, and when he has approved of it it goes back to the Keeper of the Department concerned, who sends it in with a report to the Trustees, which report also goes through the hands of Professor Owen: it is for the Trustees to say whether they will have it printed or not.

6522. In the zoological catalogue, I think, the name of Dr. Gray alone appears?—Yes, those issue from his department.

6523. So that, in fact, the editorship of that, as well as of other catalogues, appears to be with Dr. Gray?—Yes, for zoology, but the manuscript must pass through or into Professor Owen's hands, and also the proof sheets, so that he may control it in any way that he may think proper.

6524. Would you consider that Professor Owen is, we will say, responsible for the contents of that catalogue?—I consider that he is, decidedly.

6525. But his name does not appear to the public in that relation to the catalogue?—No, but it is one of the regulations of the Museum that he should see every one of those catalogues in manuscript, and that they should not come to the Trustees till they have gone into his hands for him to make any remark upon them that he may think proper.

6526. Do you consider that the Superintendent has the power to prevent the publication of a catalogue of which he might not approve?—I consider that he has the right of submitting his objections to the Trustees, and not only the power, but that it would be his duty to do so.

6527. Do I rightly understand that the Superintendent can give no direct orders to the Keepers of the Departments of Natural History?—That depends upon what the order may be. He can give no order



which would interfere with the regulations of the place. If he find that an officer do not attend to his time, or do not perform his duty properly, he can order him to be more attentive, or he can report him to the Trustees; and he can give orders on scientific questions connected with the departments under his charge.

6528. Is he competent, for example, to direct, we will say, the Keeper of Mineralogy, to make a certain arrangement of the minerals in his collection?—I consider that he is. But I must add to that, and I think this is one of the points on which Professor Owen has shown great judgment, that he has not, as I am informed, interfered with the Keepers of the Departments in the arrangement of their collections, except by advice.

6529. Is the Superintendent of the Natural History collections held responsible by the Trustees for the arrangements which are adopted?—Each Keeper is made responsible for the arrangement, that is to say, for the classification adopted in his own department; but if the arrangement were faulty the Trustees would expect the Superintendent to interfere.

6530. In that case, would it be quite fair to the Keeper to allow the Superintendent to interfere with his responsibility?—That would be a matter of discussion between them; but I consider that the Superintendent would have the power of controlling any particular arrangement; in fact, he certainly would, because that is the object of his superintendence.

6531. But would he not have to submit his objection to the Standing Committee of the Trustees?—If any question arose he would. Supposing that the Keeper of a department objected, then the matter ought to be brought, and would be brought, before the Standing Committee.

6532. So that, in fact, he is not, strictly speaking, the authority to give orders to the Keepers of the Departments on these matters?—Not independently, of course. Looking at it from that point of view I should say, No.

6533. Can you inform the Commission why the Museum is not open every day?—It is considered necessary that the students should have more quiet and leisure than they could have if the public were admitted every day, because there are not merely students in the galleries of Natural History, but we have a large number of persons who come to draw from the sculptures. It is quite possible for them to come on public days, but they are very much interrupted; and therefore it is considered necessary that there should be two days at least set apart for their more special use. Then, again, there is a certain amount of cleaning which is required.

6534. As a matter of fact in the Natural History collections it is impossible, is it not, to make any examinations of the specimens in the collections during the public days from the people coming and crowding about?—Yes. The table cases must be open, and the specimens being out would be liable to injury or even to theft.

6535. Has there occurred to you, or have you heard of, any plan by which the collections could be made accessible both to the public and to the students at the same time. I speak now of the Natural History collection exclusively?—In the present building I should say, No. Of course when we have a new museum such arrangements might be made that the students should be able to go into a place by themselves, apart from the general public. I mean those who want to examine special objects.

6536. Might it not be possible to have such access to the cases that the public should be on the one side of them and the students upon the other?—I think not. I think I know to what you allude, that the cases should open behind. That is all very well for a place like the Zoological Gardens, where you merely want to put birds and beasts into a cage, but it is impossible to arrange the objects of Natural History from behind. You require tiers of shelves, and you cannot arrange the objects when you are behind them; you must have them in front of you. I never tried to work it myself, I am not a naturalist, but that

is the answer which is given to me by those who have the collections under their charge.

6537. I daresay you have walked down Regent Street in the early morning sometimes, and you have seen the drapers dressing their shop windows, and that they do all their work from behind?—Yes; but I see the draper standing in the midst of his goods, close to the glass, with the objects before him, not standing behind them. He does not stand behind the objects to put them up, but he comes in front and makes the necessary arrangements.

6538. That is done at the close of the dressing, when they retire and leave the objects in their place?—But when you consider the number of thousands of objects that have to be put into our cases, I think you will see that it would be practically very inconvenient.

6539. Do you think it would be inconvenient for the large mammalia, for example, and generally the larger objects?—Perhaps not; but if we were to have the cases constructed to open behind, one plan should be adopted for the whole. With very large objects it is not of much consequence how you make your case, perhaps; it may be a separate case altogether; but when you come to systems of placing, I think you would find that opening the case from behind would be practically impossible.

6540. It is very desirable, is it not, that whatever specimens are exhibited should be kept free from dust?—Very desirable.

6541. And I have no doubt that you have been met by the great difficulty of all practical curators, that is to say, the difficulty of keeping dust out, if your cases are opened in the direction in which the public are circulating?—That is a question which has occupied a good deal of my thoughts and of those of my predecessor, Sir Anthony Panizzi, and we are endeavouring to remedy it as fast as we can. In the department of printed books we did succeed in keeping it out. We had cases prepared in a particular way, with linings where the textures would work one into the other; and in the department of Greek and Roman antiquities also the cases are lined and fitted so as to practically exclude the dust. It is an expensive process, but the thing can be done, but it has not been tried in the cases for Natural History, because the space is so enormous, and we have always anticipated the time when they would have to be removed, so that there was great doubt whether the Trustees ought to incur so large an expense for what might only be a temporary expedient after all.

6542. In the instance you spoke of, I presume the case is only required to be opened very rarely?—Only occasionally.

6543. That is the great difficulty, practically, to get a case which will be hermetically closed, if it has to be opened pretty frequently, we will say once a month or once in two months?—Yes, my answer would only apply to the suggestion of opening behind, but it is quite clear that you must admit the air occasionally or many of your specimens will certainly deteriorate, because, like everything else, they require a free circulation of air from time to time.

6544. Supposing, however, it were practicable to arrange the specimens in a case which opened only behind, might not the dust be kept out perfectly efficiently?—I presume so; inasmuch as I consider that dust may be kept out from a case opening in front, it may be as well kept out when it is opened from behind.

6545. I take it that the real difficulty is the pumping action, the alternate expansion and contraction of the air-pump driving the air out and the dust of the room coming in?—It may be so. I think it is very likely.

6546. If the air has any great access to the place in which the dust is raised by thousands of people every day, the keeping of the dust out is next door to an impossibility, is it not?—I look upon it as a question of expense more than anything else.

6547. Would you be so good as to state your objection, as Principal Librarian, to the opening of the Museum on Sunday, of course putting aside the theological ob-

J. W. Jones,  
Esq., F.S.A.  
13 March 1871.



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jection?—I doubt whether the public would care very much to visit it on the Sunday; that is my first objection. Again, if you open it on Sunday, you must have a staff to watch, and if the public should come in considerable numbers you will have a great deal of dirt. I think you would be incurring a considerable amount of expense, and I think that the result would not be commensurate with the expense. You must not only have men to watch, but you must have officers to see that those men do their duty, and I think you would find very considerable disinclination on the part of the officers of the Museum to assist in any such matter as that. I do not think they would like it at all.

6548. You are aware, are you not, that Kew Gardens are open to the public on Sundays?—Yes.

6549. And that the practical difficulties which you are mentioning apply there as well as to museums?—But I question whether the objects there would be injured to the same extent as they might be at the British Museum. We find the accumulation of dust very great. I gave a quantity of it to Dr. Percy, who analysed it, and I believe that Professor Tyndall made use of it in his lecture on dust. Certainly the less we have of it the better. I think Professor Owen will tell you how much injury we derive from it, and how desirable it is that we should not have more of it, unless there is some commensurate advantage, which I beg most respectfully to doubt.

6550. But so far as watching is concerned, I presume that the necessity of watching is quite as great in Kew, if not rather greater?—That may be so.

6551. (*Sir John Lubbock.*) Surely that argument would apply just much to any other day as to Sunday?—We must have it open a certain number of days. The Trustees have for some years opened it in the summer months from 12 to 6 o'clock on Saturdays, and I ought to add also that we have extended the time on the Saturday and Monday during the summer months until 8 o'clock. The Trustees give every facility that they can, but I do not myself think it desirable that they should open it on Sundays as well. We should then have it open three days consecutively during the summer months. We should have it open on Saturday afternoon from 12 till 8—and then there would be the Sunday and the Monday, and you would find that the accumulation of dirt would be very serious indeed.

6552. (*Professor Huxley.*) I think I understood you to say just now that an exchange of duplicates not unfrequently takes place in the Natural History collections, and that the principle of exchanging duplicates is recognised fully by the Museum?—It is.

6553. You object, I think, to anything like a circulation of specimens which has been proposed by certain persons?—Most decidedly.

6554. You think that it would be altogether impracticable?—I consider it so. I know that it has been suggested that certain of our specimens should be sent to provincial towns, and that a Curator should be appointed who should be the servant of the Trustees, whose duty it should be to take care of those specimens; but I think that system would not work well.

6555. It would be cheaper on the whole, would it not, to buy them?—Certainly.

6556. You stated just now, did you not, your objections to requiring the Curators to give lectures in the Museum?—Yes. I consider that it is not consistent with the proper performance of their duties as Curators to deliver lectures; but to explain the objects under their charge in the way that I have mentioned I think very desirable.

6557. I suppose within your own department you would not think it advisable that the officers engaged under you should give lectures in literature or lectures on the fine arts?—No.

6558. It would be difficult, would it not, for them to perform their duties in the library if they did?—They would not perform them properly. I am certain; they would always be thinking of their lectures instead of thinking of their catalogues.

6559. The Natural History collection is very much an object library, is it not?—Yes, certainly.

6560. Do not you think that a good part of the functions of those gentlemen who have been good enough to give explanations of the collections might be discharged by detailed labels. I do not mean to say as well, but a good deal might be done by having detailed descriptive labels such as are in existence at South Kensington?—I think that that is a very proper question for the consideration of Professor Owen and the officers of the Natural History departments, but I do not think that a detailed label would ever answer the purpose of a verbal explanation, nor to a very considerable extent. The person who was explaining would introduce incidents and anecdotes, and that would give a vitality to what he was saying, which would make it interesting, but a dry label is quite another thing.

6561. But still the collection would be much more intelligible to persons who had not the advantage of such oral explanation?—No doubt much information could be given in that way.

6562. (*Dr. Sharpey.*) I think you mentioned that all appointments were made by the three principal Trustees?—That is so.

6563. Is that on a report by any of the officers?—I will explain how those appointments are made. When a vacancy occurs it is the duty of the head of the department in which that vacancy exists to report it to the Standing Committee, and to ask, if he desire it, that that vacancy should be filled up. The Standing Committee, upon that, order me to apply to the principal Trustees for an officer of such grade, whatever it may be, and I do so accordingly, and then I obtain a meeting of the three principal Trustees and I submit to them the names of the different applicants, of whom there is always a very long list; and after examining the different testimonials and recommendations which are given, and which they do very carefully, they decide upon selecting A, B, or C, as the case may be.

6564. Supposing it were in the Zoological Department, would either the Standing Committee or the principal Trustees submit those testimonials and applications to any skilled persons in that department, and ask for reports of their opinion upon them, so as to guide them in the selection?—When a vacancy occurs in the Departments of Natural History I always myself communicate with the head of the department to know if he is aware of anyone who is more competent than others for that post, and I generally receive very valuable assistance in this respect. The names of persons so recommended are submitted to the principal Trustees; they always have special recommendations for any special qualifications that may be required. In some departments, in the Library or the Departments of Antiquities, we only require intelligent men with a good education. They must have a knowledge of languages and a good college or university training, as the case may be; but for Natural History it is quite a different thing. We require there special qualifications. I always take care, before the principal Trustees meet to appoint, that there shall be some candidate or candidates with those special qualifications whose names may be submitted to them.

6565. Do you make your communication in writing or orally of the opinion of the Keeper or head of the department?—I generally get a communication from him in writing which I put with the papers of the applicant, and all those are submitted to the principal Trustees, so that they may have everything before them.

6566. Are you quite satisfied that that system works usefully?—I think that the result has proved so. I should never ask the principal Trustees to meet until I had got one or two men who were competent to fill the post.

6567. In speaking of duplicates you said, if I understood you rightly, that it was rather an object to avoid accepting duplicates, because they were an encumbrance?—That is so; the space is so limited that the officers of the department are careful not to acquire more duplicates than they can help. In fact, if an object were offered for sale and proved to be a duplicate, it would be rejected.

6568. But supposing it were offered as a gift?—Then it would not be accepted if it were a duplicate,



unless the condition of it were such as to make it very desirable that we should have it. However, that is a point upon which Professor Owen will be able to give better information than I can, but that is what I believe to be the practice.

6569. Do any public departments, such as the Admiralty and others, or the Governors of the Colonies, contribute objects to the Museum?—Objects which are obtained perhaps through surveys. Things of that kind are generally sent to the British Museum. There was a recent case in which I believe some birds were obtained during a Survey in the Straits of Magellan, and were not sent to the Museum; but I was told the other day by Mr. George Gray that those birds were every one duplicates, and he said that if they had come to the Museum they would not have been of any particular use.

6570. Would these not have been accepted?—Coming from the Admiralty they would not have been refused, but as it was I believe that no loss or no great loss occurred in consequence of their not coming.

6571. My object in putting this question is to ascertain whether, through the agency of the British Museum, there might not be an opportunity of improving, by the distribution of duplicates, local and provincial collections?—I made a remark upon that point a short time ago. I know there is a general opinion that the number of duplicates in the British Museum is enormous, but I am told by those whose authority I am bound to accept that it is not so. I believe that so far as the Department of Mineralogy is concerned, there is a very considerable quantity of duplicate minerals, but those are very freely made use of to obtain others which we want in the way of exchange. Some of those, probably, might be spared, but then, if you send them away, you are to certain extent diminishing the funds of the Museum, because they are available for exchanges. Our funds are limited. It is a difficult thing to induce the Government to increase our grant, and therefore we are very glad to have a fund of this kind to draw upon.

6572. Supposing it were the practice to accept all duplicates, they could readily be disposed of, could they not, in the way which I have hinted at, without encumbering the Museum?—No doubt, but that would be throwing upon the officers of the Museum a very great burden.

6573. Unless there were a special officer to undertake the duty?—I should doubt the expediency of that myself. When you come to examine duplicates it is a very difficult thing to say what is a duplicate. If you work out a group the officer naturally turns to his duplicates to see if he has any which afford specific varieties, and small differences generally, which it may be advisable to retain or to describe. But you never know till you are working upon them what you can call a duplicate and what not.

6574. (Chairman.) Were those specimens sent from the Magellan Straits Expedition confined to duplicates, or were there any other specimens?—I am not qualified to speak upon that point. 29 boxes came to the Admiralty, but the British Museum received only 13, I believe. The other objects went elsewhere; but Professor Owen, I know, has drawn up a report upon that subject, and if I may venture to say so he will give the Commissioners better information upon it than I can.

6575. Is there any other point arising out of your examination, or suggested by it, upon which you would wish to make a communication to the Commission?—I believe I sent to Mr. Lockyer a paper showing the number of persons who have visited the Museum upon the Saturday and Monday evenings. I will put it in, because the Trustees will make the same experiment this year, and it is possible that when it becomes better known more persons may come. At present the numbers are not very large. It was said that a workman would not bring his children as he would in the earlier part of the day, and therefore I ordered an account to be taken of the children that came, and I find that it is really very satisfactory.

J. W. Jones,  
Esq., F.S.A.  
13 March 1871.

The following table was delivered in :—

MEMORANDUM OF VISITORS to the BRITISH MUSEUM during the EVENING. 1870.

Date.	Persons passing in.				Total passing in.	Persons passing out.		Total passing out.						
	Grown Persons.		Children.			6-7 P.M.	7-8 P.M.							
	6-7 P.M.	7-8 P.M.	6-7 P.M.	7-8 P.M.										
Monday, May 9th	-	-	47	28	Not taken the first day.		75	Not taken the first day.						
Saturday, May 14th	-	-	50	26	13	2	91	123	126	249				
Monday, May 16th	-	-	81	23	20	7	131	83	145	228				
Saturday, May 21st	-	-	96	24	10	3	133	124	156	280				
Monday, May 23rd	-	-	49	27	14	11	101	117	107	224				
Saturday, May 28th	-	-	39	17	—	5	61	68	114	182				
Monday, May 30th	-	-	42	21	12	2	77	72	61	133				
Saturday, June 4th	-	-	43	13	5	3	64	91	82	173				
Monday, June 6th	-	-	109	28	37	17	191	199	237	436				
Saturday, June 11th	-	-	44	■	7	1	58	85	61	146				
Monday, June 13th	-	-	50	50	18	1	119	53	123	176				
Saturday, June 18th	-	-	65	20	■	3	92	85	83	168				
Monday, June 20th	-	-	26	32	7	7	72	124	98	222				
Saturday, June 25th	-	-	65	23	15	3	106	67	106	173				
Monday, June 27th	-	-	60	22	13	12	107	102	153	255				
Saturday, July 2nd	-	-	37	11	16	■	68	102	84	186				
Monday, July 4th	-	-	25	9	18	■	58	85	60	145				
Saturday, July 9th	-	-	48	13	■	1	67	72	87	159				
Monday, July 11th	-	-	15	34	■	4	58	78	85	163				
Saturday, July 16th	-	-	30	20	2	—	52	58	52	110				
Monday, July 18th	-	-	43	45	■	1	95	97	91	188				
Saturday, July 23rd	-	-	32	19	■	7	62	54	60	114				
Monday, July 25th	-	-	21	19	5	8	53	65	47	112				
Saturday, July 30th	-	-	29	21	9	0	59	48	63	111				
Monday, August 1st	-	-	30	7	7	0	44	57	56	113				
Saturday, August 6th	-	-	41	19	■	4	69	62	57	119				
Monday, August 8th	-	-	38	15	9	■	65	107	61	168				
			1,255	592			266	115			2,228	2,278	2,455	4,733*
			1,847				381				4,733			

\* The number of visitors passing out on the 9th of May was not taken.



J. W. Jones,  
Esq., F.S.A.

13 March 1871.

6576. (*Sir John Lubbock.*) How were those numbers taken?—They were taken by a man who stands at the door.

6577. Are the numbers visiting the collection in the daytime taken in the same way?—By a person standing at the door.

6578. Have they always been taken in that way?—Always in that way. When I say the numbers visiting the collection, I mean the numbers of the public. The numbers which are given from the Natural History Departments represent the visits of students and not the visits of the public, because they are persons who make application to the Keepers, and are assisted by the Keeper or assistant-keeper, or some person in the department, and a register is kept of them. In the Botanical Department, which is a popular department, the numbers have increased. There were about 215 in January and February this year, which is about one-third more than in the corresponding months in last year, and generally the numbers are very satisfactory. There were 2,655 visits paid to the Department of Zoology during the last year, 1,041 to Botany, and 818 to Geology. I have no return for Mineralogy.

6579. Those are visits to the special departments?—Yes, to special departments, for the purposes of study.

6580. I think I understood you to say, that duplicates are found very useful for the purposes of exchange, and act, in fact, as coin almost?—Yes.

6581. Then would it not be well to accept all duplicates in order to utilize them in the manner that you have been suggesting?—I think not: we are very glad to utilize all the duplicates that we have, but they occupy a great deal of time and give much trouble, and if we were to invite contributions of duplicates for that purpose we should require, as one of the Commissioners said, some one to look especially after them.

The witness withdrew.

RICHARD OWEN, Esq., M.D., F.R.S., examined.

6587. (*Chairman.*) You were, I think, formerly the Curator and Professor of the Hunterian Museum?—Yes.

6588. Will you be good enough to inform the Commission of the period and the nature of the services which you had to discharge in that office?—The period during which my services to the public in relation to the Hunterian Museum were conducted, was about 30 years; from the year 1827 to 1855.

6589. What was the character of the duties attaching to those offices?—The principal condition that led to my appointment was the need which was very much felt at that time of a descriptive catalogue. The Commission are aware, no doubt, that the Hunterian Museum was purchased by Parliament in the year 1799, and put under a Board of Trustees. In the Act of Parliament it is stated that there should be a Board of Trustees, to consist of 16 members, by virtue of their public offices, and of 14 others, to be appointed, in the first instance, by the Lords of the Treasury, and afterwards to be elected, as vacancies might happen, by a majority of the remaining Trustees. The trust was founded in that Act of Parliament upon the plan of the Trustees of the British Museum: the Trustees by office being the Lord Chancellor, the First Lord of the Treasury, the Chancellor of the Exchequer, the First Lord of the Admiralty, the Speaker of the House of Commons, the Secretary at War, the President of the Royal Society, the President of the Royal College of Physicians, and the four Censors of the Royal College of Physicians, the Regius Professor of Physic in the University of Oxford, the Reader in Anatomy in the University of Oxford, the Regius Professor of Physic in the University of Cambridge, and the Professor of Anatomy in the University of Cambridge, and there were other Trustees by election. That is the constitution of the Board of Trustees having in trust the Hunterian Museum, so purchased by Parliament, but with this difference, that that Board of Trustees is inspective, but not administrative. The Museum was confided to the Royal College of Surgeons, the Com-

6582. If they are so useful, would it not be well to have some one to look after them?—That is a financial question. The duplicates generally are found to be very tiresome things; only when we have them we are very glad to make use of them.

6583. How often do the Trustees usually find it necessary to meet?—They meet regularly twice in the month, that is to say, on the second and the fourth Saturday, during the sitting of Parliament; and once a month during the rest of the year, with special meetings, if any special matter require it, with the exception of the months of August and September, when there is no meeting of the Trustees.

6584. What is the present number of Trustees?—50.

6585. Is it not the case that out of those 50 there are only two who can be said to have devoted any special study to Natural History?—There are Sir Roderick Murchison, General Sabine, and Sir Philip Egerton, who is an extremely good naturalist, particularly in the branch of Ichthyology. And the Duke of Argyll takes a great interest in Natural History, particularly in Geology.

6586. Do you not think that it would be very convenient to have a few more well acquainted with that very important branch of the objects covered by the Museum?—I think, seeing that the Trustees who do take an interest in that branch are very constant in their attendance, and that they always have the advice of the Superintendent of Natural History and of the officers of the departments whenever they feel the slightest necessity for it, there really are enough. It is not as if there were any special interests to defend. The questions for the Trustees are always very ably put before them, and I do not anticipate any practical inconvenience from the number of Trustees who have studied Natural History not being larger than it is.

pany of Surgeons about that time being raised to the dignity of a College, and having certain privileges granted them for deriving money from the diplomas which they conferred, and for the usufruct of this Museum they undertook to be at the expense of preserving it, and the fees for my services there were paid by the College of Surgeons.

6590. Your opportunities of usefulness were in promoting and extending the application of the Museum to the advancement of science: will you be good enough to describe in what way?—The chief work during that 30 years, I may define as connected with the making of catalogues. My first catalogue was a collection of undissected animals, which formed a certain series in Natural History, and it was of use, because of some invertebrate species in them, individuals which Hunter himself had dissected, and placed in his greater series of physiological preparations, which in fact is the essential and characteristic part of the Hunterian collection. But the chief difficulty in making a catalogue of them was this, that Hunter had not left, nor indeed could he in his days have left, the names of the animals he dissected. The names were first to be determined, and the result of that part of my labours is shown in five quarto volumes, descriptive of that part of the collection. The catalogue of the Osteology and dry preparations followed. After that came a series of fossil remains, which was much larger than was at all supposed; I mean the original Hunterian ones, much more extensive than was supposed, showing that Hunter had paid a greater amount of attention to that branch of science than was suspected in his day: with regard to these I completed the catalogue of fossil mammalia, birds, and reptiles, and finished the first part of the Invertebrates, including Cephalopods, of which Hunter had left a very instructive, extensive, and remarkably valuable collection, which he had made a few years before his demise. Parliament in 1799 seemed to have had a very good view of the utility of a museum of that kind, with reference to the public instruction and to the advancement of

R. Owen, Esq.,  
M.D., F.R.S.



science, for they also made this a condition "that one course of lectures, not less than 24 in number on comparative anatomy and other subjects, illustrated by the preparations, shall be given every year by some member of the company." Then in relation to your question I may state that, before my appointment in the College, 24 lectures illustrated by preparations were given, but they were not 24 lectures on comparative anatomy only, they were indeed on comparative anatomy and other subjects, but were divided between two Professors, each giving 12, and that continued down to the year 1835, when Sir Charles Bell gave 12 lectures on comparative anatomy, or rather physiology, which was his subject. It was then, with reference to certain suggestions that were considered and discussed by the Council and the Board of Curators, determined that this requirement should be fulfilled more according to its letter, and I agreed, and felt myself capable of undertaking, to give 24 lectures on comparative anatomy, illustrated by the Hunterian preparations and others, and I was accordingly in 1835 appointed Hunterian Professor in addition to my office as Curator, and that duty I continued to perform until the year 1855.

6591. There were also probably some monographs which flowed from your work in the Museum?—There were a few subjects remarkable for their novelty and rarity or their great desirability by naturalists generally, and which the Curator thought fit to publish *in extenso* in the catalogues illustrated by a series of plates. Amongst them I may cite one on the Nautilus Pompilius, and one on the Mylodon.

6592. At what time were you appointed to the superintendency of the Natural History Department in the British Museum?—Shortly after the resignation of Sir Henry Ellis in 1855. As the result of a motion made in the House of Commons by the member for South Lancashire, Mr. Heywood, at that time, and other considerations, it was thought that the Museum had grown to that extent, and especially in its Natural History Department, that it was no longer desirable to have the whole under one salaried administrative head, as it had previously been, but that there should be some one to have that relation under the Trustees to all the Natural History Departments, and that office, which I have the honour to hold, was proposed to me and accepted under the title of Superintendent of the Natural History Departments. I received my appointment early in 1856.

6593. Have you at any time made any report upon the space occupied by the Natural History collection, and which may be required for it by the probable additions of the ensuing 30 years?—My first work was to endeavour to get some clear ideas of the relation between the space allotted for the different Departments of Natural History at the British Museum, and then of the extent of the several collections. Dr. Gray and others had reported upon the great need of further space prior to that time, and the want of space was very much felt. From time to time I found that propositions had been made to the Trustees, or suggested by the Trustees, for additions, sometimes of an additional gallery, but always at that time with reference to utilising more and more the space then allotted to Natural History, which is, in fact, the space still allotted to it, and to me it was quite clear that those proposed plans were entirely incompetent to meet the exigencies of the Natural History. I more particularly felt this state of things in the British Museum, that to make progress in those branches of Natural History which include individuals of unusually large size, Pachyderms, Rhinoceroses, Tapirs, Elephants, and more especially the Cetacea, of course the specimens must be had under conditions under which they could be compared, and it was quite evident that no private museum, and no museum belonging to any society, such, for example, as the Zoological Society, or any other, could be expected to afford to zoologists the means of advancing those branches of Natural History, and that nothing short of a museum formed and maintained by the nation could do that, or could be expected to do it. And, therefore, taking those things into consideration, and also this,

that as the space then at our command, which is the space now at our command, from the time I held that office till the present year, only permitted three, what may be called, natural classes of natural objects to be arranged in a way to give the information which they ought to give, that is to say, systematically, it was evident that a considerable addition would be required, in order to similarly arrange all of what may be considered the natural classes, not only in Zoology but in Palæontology, in Botany, and in Mineralogy; the three classes of Natural History that we had room to arrange in an instructive way, being the class of Birds, the class of Mollusca, so far as they are represented by shells, and the class of Minerals. The other classes of natural objects are placed where they can be most conveniently disposed, and many classes consequently are combined together in the same room, as every visitor to the Museum of course knows very well. But besides that, we have a large proportion of specimens in the vaults beneath the British Museum, used as warehouses and also as workrooms. Then, taking into consideration the ratio of the increase every year for some years previous to 1859, for I was two years going through that work after my appointment, I submitted the results of that examination to the Trustees in a report, dated the 10th of February 1859. In order to make the views which I had arrived at more easily comprehensible to the body of Trustees, only a portion of whom were, as Naturalists, competent to enter into the details of the case, I gave in one ground plan (and it is the only way in which you can give an idea of the subject) a notion of the space which might be required if every class were fairly and equally arranged after the fashion of the three which are so arranged and displayed, and with reference to such an increase as might be expected to go on in the ratio of the increase that had been received, and for thirty years of which increase that plan is expressly stated to have been prepared. It should also be understood that I desired merely to convey to the eye of a practical man the proportional assignment of galleries to the several departments and classes, regard being had to the utmost economy of building space, and not that I intended to advocate any particular form or site of building or style of architecture. Moreover, besides pointing out the principles and conditions of space on which the National Museum of Natural History should be considered or looked forward to, I thought it my duty to state in explanation of this plan, that "In the subjoined 'plan' is shown space for a theatre, on the belief that administrators will consider it due to the public that the gentlemen in charge of the several departments of the National Collection of Natural History, should have assigned to them the duty of explaining the principles and economical relations of such departments; in short, elementary and free courses of lectures, as for example, on Ethnology, Mammalogy, Ornithology, Ichthyology, and Herpetology, Malacology and Conchology, Entomology, Zoophytology, Botany (recent and fossil), Geology, Palæontology, and Mineralogy," there being Keepers or Sub-keepers or heads of departments for each of those classes then, as they are now, obviously perfectly competent to give the principles of those several departments of Natural History in a course of lectures. I was subsequently called upon to go more into detail on this question, and more especially to give my views as to what might be required for the Museum for actual needs and also "for some time to come." The more detailed grounds for that, so required, were given in a report of the date of the 6th of March 1862, in which I recommended that the building should be of two stories, and that not less than five acres of ground should be secured; not to be covered at once by a building, for that would not be required, but to give the means of extending when the need should come; feeling most acutely, with all my colleagues, that our present position fetters us: in consequence of which now, and for 16 or nearly 20 years past, we have been compelled to pack and to crowd, and have been precluded from those scientific arrangements and displays which we should wish to make,

R. Owen, Esq.  
M.D., F.R.S.

13 March 1871.



R. Owen, Esq.,  
M.D., F.R.S.  
13 March 1871.

because space could not be got in the part of London where the Museum now exists except at conditions of expense which were duly laid before the House of Commons by Lord Palmerston on the occasion when the House consented to purchase the 16 acres which they now have at South Kensington: also by Mr. Gladstone, the Chancellor of the Exchequer in 1862, when he proposed to the House the devotion of five acres of that ground for the proposed future Museum of Natural History. Besides that I gave, in still greater detail, my grounds or reasons for thinking that five acres of ground should be secured for a Natural History Museum in a lecture given at the Royal Institution on the 26th of April 1861, which was fully reported at that time in the "Athenæum," and subsequently published in 1862.

6594. In relation to your anticipations of this increase during the period of 30 years, can you state the ratio of additions to the Museum which have occurred during your superintendency?—I have drawn out a table of the annual increase of specimens of Natural History in the British Museum. In 1857 the additions to zoology numbered 48,044 registered specimens; in geology, 9,880 specimens; in mineralogy, 103 specimens; in botany, 5,135 specimens; the total in the year 1857 being 63,162 specimens received. I must tell you that we instinctively are upon the defensive against receiving any additional specimens that we can possibly avoid. An additional specimen must have really true and strong claims for our reception of it, either as recommending it for purchase or as receiving it as a donation. There is no doubt, as the Principal Librarian has just said, that collections sent from public departments such as the Admiralty are received and registered: they also come from other sources which cannot be declined, as well as from public departments, and of course all such donations are expected to be shown at the British Museum. A Surveying Expedition, for example, returns from some remote part of the world, and it is known that collections have been obtained in Natural History and in Palæontology, and Foreign Professors and others naturally expect to see them at the British Museum, and so we receive them. In regard to "duplicates," we are very careful to be sure that they are duplicates before we put such aside, after incorporating novelties and additions in the Museum. But notwithstanding all this reticence, which arises from the great difficulty with regard to space, in 1857 the total of additions registered was 63,162 specimens; in 1858, 52,411; in 1859, 44,913; in 1860, 49,923; in 1861, 31,532; in 1862, 29,820; in 1863, 112,454; the additions to zoology in that year being 98,754 specimens; in 1864, 23,932; in 1865, 45,139; in 1866, 104,199: Zoology receiving in that year 92,818 specimens. In the 12 years of my superintendence the additions that we have received, and which we have to keep in good condition, and which we do keep in the best condition which we are able, always looking forward year by year to the relief of getting a museum where we can display them, and make them more useful to the public, amount to 710,215 registered specimens. (*The witness delivered in the following table.*)

ANNUAL INCREASE of Specimens to the NATURAL HISTORY in the BRITISH MUSEUM.

—	Zoology.	Geology.	Mineralogy.	Botany.*	Total.
1857	48'044	9'880	103	5'135	63'162
1858	42'691	4'500	700	4'520	52'411
1859	33'307	3'550	3'186	4'870	44'913
1860	25'222	10'000	10'028	4'673	49'923
1861	16'121	5'522	1'525	8'364	31'532
1862	13'120	3'144	1'200	12'347	29'820
1863	98'754	3'053	067	9'080	112'454
1864	7'688	4'651	634	10'959	23'932
1865	16'700	10'079	3'023	14'737	45'139
1866	92'818	4'061	672	6'648	104'199
1867	81'228	9'156	813	10'960	102'157
1868	24'144	10'372	1'036	15'021	50'573

Total of 12 years' additions, 710,215.

\* These are the lowest estimates of numbers that can be made from the general statement of numbers of species in reports of the Keeper of the Botanical Department.

RICHARD OWEN,  
Superintendent.

6595. Will you state what has been done in the way of directly imparting elementary knowledge to the public in connexion with the Museum?—Of late, within two or three years, we have (I may speak for myself) most willingly and gladly received propositions from gentlemen, who have benevolently and wisely devoted part of their time to the well-being of the wage-population, and we have received numbers of the wage-people on certain days, who have been brought to the Museum under the superintendence of one or more of those gentlemen, and have received from myself oral expositions in the principal objects of one or other of our galleries, generally for an hour, or an hour and a half: they have received that information with great attention, under the difficulties of our galleries, from the narrow spaces that we are obliged to limit for the circulation of the public: they have arranged themselves in an extremely orderly fashion, and have gone away very well pleased and satisfied with what they have heard. Dr. Birch, Mr. Newton, and Mr. Woodward have, also, given that kind of information in the galleries. In a similar way oral instruction has been given to classes. For example, for some five or six years past, the Professor of Geology in the Military College at Woolwich has brought his class, and has intimated to me a desire that they should have such instruction, which I have given them occasionally. The classes of professors in town have been brought there. Professor Tennant has sometimes brought his class from King's College, and requested me to give an explanation of certain fossils, and so on, which I have done. I think that would include all that in my knowledge has been done indirectly, or orally, towards imparting elementary instruction to the public.

6596. Is there anything further of the same kind proposed to be done?—Not that I am aware of.

6597. As you anticipate beneficial effects from affording that information, have you a suggestion to make upon those subjects to the Commission?—I have already stated it in print in various ways. In my address to the British Association, for example, in 1858, I spoke of the desirability of the heads of departments, and the keepers or sub-keepers of departments, giving each a short elementary course of lectures. I said, "That the Curator of each class of animals should have assigned to him the charge of delivering a public course of lectures on the characters, principles of classification, habits, instincts, and economical uses of such class." Now, the ground upon which I have recommended that, has been the experience of the benefit to myself, in doing the work of Curator at the Royal College of Surgeons, from having, as a duty, to give an elementary course of lectures—24 lectures every year. I never found that the delivery of those lectures did interfere with the Curator's work. On the contrary, it frequently brought more home to my knowledge, than I should have had before, the want of particular specimens, missing links, things desirable to have, in order to illustrate some point. I do not know that I should have seen those wants so immediately, or so clearly, if I had not been obliged, as a lecturer, to feel that I required them. Some auditor would write to the part of the world where the objects wanted were to be found, and take steps to acquire them, and we frequently in that way did acquire desiderata sooner than we otherwise should. Then, another benefit to the collection, *qua* collection, was this, that many of those who heard the lecture heard the remark, that such a thing would have been illustrated if we had had it, and I found that I frequently had a communication afterwards, stating that such a specimen could be given, and so the Museum became enriched by needed specimens. Besides the stimulus that those lectures gave to men going abroad to keep up their friendly relations with the Professor and to send him notes on the living animals besides specimens, all which formed a considerable element in the advancement of Natural History, there is, also, another consideration, viz., that if the Keeper of any given Department had had



it assigned to him as a part of his duty to come before the public and give lectures on the branch of Natural History connected with his Department, he must necessarily have been much more fit for his duties than where his qualifications were unknown comparatively to the public, limited to his gallery or his work there, and there being no public test of his fitness with reference to his scientific qualifications. I do not mean this to apply to any of the gentlemen who are now in charge, but there have been appointments, as given in evidence of former commissions with reference to the working of the Museum, which the duty of lecturing would have made impossible. So in my humble opinion the duty of lecturer would work well in the ways I have mentioned. And I should like to add this, that if Mr. Gladstone's proposition in 1862 to secure five acres upon which to commence a building for immediate needs (he proposed no more) had been adopted, I feel sure that such a museum having been erected in such a place, the Superintendent and Heads of Departments would have felt it their duty to take a more direct share in promoting public education. Had the motion been carried 10 years ago you would have had the requisite galleries for instructive arrangement of specimens, and, probably, those elementary lectures. And I would add a word further in reference to the promotion of instruction in science, and especially in Natural Science in the ordinary educational establishments of this country—because, when one speaks of this we are met with the question, Where shall we get our teachers? Who is to teach those elements of Natural History? And I answer, that if 24 lectures had been given in the way and on the subjects I have just mentioned, to men and women looking forward to the function of schoolmasters and schoolmistresses, I will be bound for it that at this time you would have had a supply as the fruit of those elementary lectures. And I cannot look back without feelings of the deepest regret at the opposition made to the carrying out of that plan which the Chancellor of the Exchequer proposed to the House of Commons on the 19th of May 1862. It is miserable to think how that good was obstructed. If the Commission will permit me, I will just read one of the remarks which led astray the House upon that subject. I am quoting from Hansard, the 166th volume, page 1910. The honorable member for Galway said, "They had on the one side, and standing alone, Professor Owen and his 10 acre scheme, and on the other side all the scientific gentlemen who were perfectly unanimous in condemning the plan of Professor Owen as being utterly useless and bewildering. To give the House some idea of that gigantic plan he might mention that a part of it consisted of galleries of 850 ft. in length for the exhibition of whales. The scientific men examined on the subject one and all disapproved of that plan *in toto*, and they advocated what was called a typical mode of exhibition limited to objects of general interest and utility, that there should be drawers in which all other specimens should be kept and that there should be studies to which scientific men could resort for the purpose of comparing and examining specimens. Common sense must point out to every man save the mere enthusiast that *that* was the proper course to adopt." One could not be present just to suggest what might have been suggested, and I should like to have this appended to that quotation. The reply would be, "But if specimens are not to be exhibited and are too big for the drawers, it would be useless to resort to the studies. A zoologist, desirous, like Hunter and Cuvier, to examine and compare the character of whales, exercises the faculty of common sense in estimating the space required for the specimens. Something worse than mere enthusiasm is manifested by the notion of packing all specimens not of general interest in drawers, unless the study of Natural History be prohibited when species get beyond a certain size." However, that and similar arguments

prevailed, an entire silence being kept of the protest that I had made originally with reference to this display upon one plane (pointing to the "Plan" in the Report of 10th February 1859) of what might be wanted after 30 years' additions. The unfortunate vote of the House at that time was vindicated by the following letter addressed to the editor of "The Times," and dated "Athenæum," May 20th, 1862. "Sir,—I trust you will permit one of the general body of naturalists who have persistently and unanimously opposed that plan of arrangement of animal specimens upon which the demand for enormous space and the consequent removal of the Natural History collections of the British Museum is really based, to express his satisfaction at the decision of the House of Commons last night, and to assure the majority who voted against the Chancellor of the Exchequer's bill, that they have earned the gratitude of men of science." Then there follow certain paragraphs personal to myself which I will not allude to. "If there could be provided anywhere, either gradually or at once, six such rooms as the ornithological room, which is 300 and odd feet long by 45 feet wide, with appropriate offices."

(*Professor Huxley.*) If any part of that letter is read, I must request that the whole of it be read.

[The witness was requested to withdraw. After some time the witness was again called in.]

(*Chairman.*) The Commission have fully considered this question, and they have decided that if you quote any part of the letter, the whole of it must be read.

(*Witness.*) It is to be found in "The Times" newspaper, the 21st of May 1862.

[The remaining portion of the letter in question runs as follows: "As a working naturalist, it is a matter of entire indifference to me whether the Natural History collections remain at Bloomsbury or are transferred to South Kensington. I, since 1858, have urged, in common with the leading practical naturalists of this country, the propriety of placing the government of that part of the Museum in the hands of a single administrator (with or without the Board of Trustees or of Visitors), who shall be directly responsible to one of Her Majesty's ministers. I am further of opinion that Professor Owen's valuable and long-continued labours have earned for him a perfect right to occupy the office so created. Thus, Sir, I have nothing to say against the carrying into effect even larger changes in the administration of the Natural History collections than were proposed last night. On the contrary, there are some which I should highly approve, but I have no sympathy with the Chinese method of burning down your house to get a dish of roast pig, and the ruin of the usefulness of the collections, both to men of science and to the public, which would naturally follow upon the carrying out of Professor Owen's scheme, would be rather too heavy a price to pay for the advantages of independent government. Without doubt the Superintendent of the Natural History departments of the British Museum is the profoundest osteologist now living, nor is it possible for the general public to estimate too highly his scientific merits and abilities, but when his justly earned high reputation in those and cognate branches of science is converted into an engine for forcing upon the House of Commons a measure founded on his views regarding matters of classification and arrangement, upon which he is no more authority than many who are totally opposed to him, one is glad to see the practical good sense of our legislators rush to the rescue. Except as a man of science, I have no interest, direct or indirect, present or expectant, in what becomes of the British Museum, but were I in the place of my friend Dr. Gray, the Keeper of the Zoological Department, I should be perfectly prepared to take the whole responsibility of acting upon the following statement, which I made before Mr. Gregory's Committee in 1860, and which is published at page 89 of the Blue Book: 'If there could be provided any-

R. Owen, Esq.,  
M.D., F.R.S.

13 March 1871.



R. Owen, Esq.,  
M.D., F.R.S.

13 March 1871.

“ ‘where, either gradually or at once, six such rooms  
“ ‘as the ornithological room, which is 300 and odd  
“ ‘feet long by 45 wide, with appropriate offices, not  
“ ‘only the existing collections, but all the collections  
“ ‘which the Museum is likely to receive for the  
“ ‘next 50 years, might be arranged in those six  
“ ‘rooms, so as to give the utmost amusement and  
“ ‘instruction to the public and to afford the utmost  
“ ‘facilities to men of science for their studies and for  
“ ‘the advancement of science. If six such rooms  
“ ‘could be provided they would cover little more than  
“ ‘a couple of acres if all were built on the ground  
“ ‘floor, although I do not think that necessary, and I  
“ ‘do not see why they should not be two-storied;  
“ ‘and I conceive that if those rooms were provided  
“ ‘all the space now occupied by zoological collections  
“ ‘in the British Museum might be given up to other  
“ ‘purposes.’ I have reason to believe that every  
“ ‘eminent naturalist conversant with museum work,  
“ ‘and having no interest in this question of removal  
“ ‘from Bloomsbury, will support me in this state-  
“ ‘ment, and therefore I cannot but think that it is to be  
“ ‘regretted that the Chancellor of the Exchequer should  
“ ‘have been so far misled by one-sided information as to  
“ ‘assert dogmatically, and without qualification, that  
“ ‘one or two acres would not meet the exigency of  
“ ‘the case.’ I affirm, on the contrary, that two acres  
“ ‘will amply meet every exigency of the case, and that  
“ ‘Mr. Gregory’s epithet of ‘preposterous,’ as applied  
“ ‘to the demand for 10 acres last session, was perfectly  
“ ‘apposite.”]

(*Chairman.*) Will you now be kind enough to proceed with your evidence?—The writer, assuming that he speaks in the name of all other men of science except myself, gives certain recommendations which, coming from him, would greatly tend to prevent the acquisition of what, in my humble opinion, I believe to be absolutely necessary in reference to the space for the National Collections of Natural History. He ends his letter, for example:—“If six such rooms could be provided, they would cover little more than a couple of acres if all were built on the ground floor, although I do not think that necessary, and I do not see why they should not be two-storied.” Here I would beg the favour of the members of the Commission to have the kindness to look over my Report, on which the recommendation of the Chancellor of the Exchequer was mainly founded, of the 6th of March 1862, where the idea of not building on less than two acres was never in question. As this letter stood, it would appear as if it were the object of the recommendation that had been made to build a museum of Natural History on the ground floor, and spread it out after the fashion of that diagram, which I was obliged to make in order to give the view which I wished to impart to the Trustees. Then the writer goes on and says:—“I affirm, on the contrary, that two acres will amply meet every exigency of the case, and that Mr. Gregory’s epithet of ‘preposterous,’ as applied to the demand for 10 acres last session, was perfectly apposite.” Now, this being put in in the name of all other naturalists except myself, it was very agreeable to me, not that I needed it for my own convictions, but of course it was agreeable to me to find about that time, and quite irrespective of my plan, the unintentional, confirmatory evidence of the State of Massachusetts, in the United States. Having vessels to all parts of the world, the people of Massachusetts thought it right to have a State Museum, and the Governor of that State, Mr. George Banks, in his Dedicatory Address on the opening of the State Museum of Comparative Zoology, alludes to the importance of the object signified by Mr. Gladstone. The truth is, that the objects to be shown in that museum are by no means so extensive as those which are under my superintendence, and which must be exhibited in our National Museum of Natural History, but they assign for that museum precisely the figure that I had recommended, and which was recommended to the House by Mr. Gladstone, not that that space should be covered at once, but that

they should have five years to go upon. What has been the result? They have built a museum within five years covering three acres—a museum of three stories, and there are Annual Reports which are sent to this country, and which are no doubt to be found in the Royal Society, by Professor Agassiz, at whose recommendation this idea of space to that extent was made, and you will see by those Reports that that museum has been built upon principles, which were laid down, I may say, by as eminent a zoologist as now exists in the world, and the objects are arranged under the circumstances best adapted to convey the information which a museum is expected to convey. The extent of superficial space recommended by Professor Huxley in his letter according to the basis of the gallery of which he gives the length of 300 feet; the extent of that would be 1,800 feet lineal, altogether. Professor Agassiz’ Museum in Massachusetts, built in 1862, will afford, when completed, exhibition space equivalent to a superficial area of 5,000 feet, or to galleries with a free width of 50 feet, which is more than the width of our ornithological gallery collection, and a length of about 6,000 feet. Here we have a difference of space of 6,000 as compared with 1,800. I am glad to find that I am able to quote a practical zoologist like Professor Agassiz, and that I am not to be regarded, as was represented to the House of Commons by the Honourable Member for Galway, and by Professor Huxley, and to the whole world, as standing alone in the conclusions that I have come to as to the space which is required.

6598. As respects the giving of lectures in connexion with the Museum, you are of opinion that the conjunction of the function of Curator with that of Professor would be beneficial in all respects to the Museum?—That is quite the result of my experience.

6599. If those functions were so united you would think it expedient that there should be some means of improving the position of the Curators?—No doubt.

6600. You would desire that they should have a larger emolument than that which they at present receive?—There is no doubt that that would increase the ground of their claims as public servants to receive higher emoluments, for in a return published by order of Parliament, including all the memorials of the several classes of officers in the British Museum, there is a very intelligible comparative table of the emoluments received by the public servants in other civil departments, and one may say that the qualifications and capabilities of the gentlemen in the equivalent departments of the British Museum are at least equal to those in the Paymaster’s office and other departments of the public service. Now, therefore, if the gentlemen in charge of those several classes and sub-classes of Natural History should satisfactorily give to the public 24 elementary lectures, I do not conceive that more would be needed for the purpose that I have in view, and I cannot doubt but that the Treasury would feel that they had the support of public opinion in remunerating them somewhat more adequately for their services.

6601. You are contemplating a series of 24 lectures similar to those which you gave as Professor of the Hunterian Museum?—I am.

6602. But in addition to those, might it not perhaps be expedient that there should be some work done by assistants who might accompany bodies of working men to visit the collections in explanation of the collection?—Whenever it was thought that the wage-people would be instructed in that way, no doubt the time of the assistant could be given, without any great detriment to his work by doing so.

6603. You are aware, I presume, that certain plans have been prepared for the Natural History Museum, which it is proposed to erect at South Kensington?—I have been in constant communication with the Architect and the officers of the Board of Works with reference to those plans for nearly a year past.

6604. Those plans are now in this room, and with respect to them the Commission would be very desirous of receiving any suggestions that you have to



make?—The concluding Reports which we had the honour to make to the Board of Trustees about a month ago, embodying my own with the Reports of the keepers of each of the principal departments, express our final and conclusive judgment as to those plans as being perfectly satisfied that, considering the extent of the building which the Chief Commissioner of Works proposed to sanction, it would give us the space which is required for our present collections; but you will no doubt see the Reports of Dr. Gray, Mr. Waterhouse, Professor Maskelyne, and Mr. Carruthers. I have no doubt they will all be called for by Parliament and printed, and you will then see, and it was certainly gratifying to me as confirming my judgment with regard to the space required, that they one and all agreed with me in my estimates of space, and if they were disposed to offer anything like a shadow of objection it was upon the ground that the space was barely sufficient for their present wants. Then, on the other hand, one of the arguments which led us to be unanimous with reference to that plan, seeing the paramount advantage of getting it done without further delay, was that we should at all events exhibit our collections under a better light; that we should exhibit the other classes more in accordance with the way in which the three classes which I have above mentioned are now exhibited at the British Museum; and, besides, that we should have a feature which I have always recommended, namely, a large apartment for a Type Museum or a museum of elementary instruction, together with that which we already have at the British Museum, viz., a room for the exhibition and explanation of the British Natural History. The proposed Type Museum will be so formed as to be capable of being used as a good lecture-room for elementary lectures. The British collection and the typical collection will be those parts of the Museum which could with perfect safety be lit up with gas so as to permit the public to be admitted in the evening, and I believe giving all the information and pleasure that evening visitors would require. Many Members of Parliament from time to time have spoken about it, and those are the general features of the plans which you now have before you.

6605. I understand you to refer for the full exposition of your own opinion and that of the Curators of the several departments to the Reports which have been presented to the Treasury?—Yes.

6606. (*Professor Huxley*.) Will you be kind enough to inform the Commission whether you forwarded to the Secretary a *précis* of your evidence as is usually done at the request of the Secretary?—I do not know what you mean by a *précis* of the evidence. I forwarded to the Chairman of the Commission the subjects upon which it appeared to me that I could speak with most advantage with reference to the aim of this Commission.

6607. Did not Mr. Lockyer ask you to supply such a document to the Commissioners?—I do not know that he did. He informed me that Mr. Winter Jones, I think, had sent some account of the subjects upon which he wished to be examined.

6608. You did not then decline to send a *précis* of your evidence to them?—No, I do not remember that the question was asked.

6609. I understood you to say that you considered one of the great advantages that would be derived from the giving of lectures by the Keepers of collections to be, that they would be able to supply the teachers of elementary schools with the instruction requisite for them?—Yes, that is one advantage.

6610. Do you consider that the number of lectures that you have mentioned, namely 24, would be the outside of those given by those persons?—I do.

6611. Do you consider that a person could be qualified to become a teacher of elementary zoology by hearing 24 lectures upon that subject?—Not by hearing 24 lectures, but 12 distinct courses of such, and by the guidance that those lectures would give him with regard to his own elementary reading and studies. I do not suppose that anyone could be made into a

teacher of Natural History merely by listening to lectures.

6612. Do you contemplate that each keeper or curator shall give a course?—Yes, in reference to the subjects which I have mentioned.

6613. Will you mention what were those subjects?—Ethnology, Mammalogy, Ornithology, Ichthyology and Herpetology, Malacology and Conchology, Entomology, Zoophytology, Botany (recent and fossil), Geology, Palæontology, Mineralogy.

6614. Then those are to be strictly elementary lectures?—That requires a definition of the meaning of "strictly elementary."

6615. Are they to be elementary in any sense whatever?—The course of lectures must be necessarily elementary that are given to the class of auditors coming to hear them, and I suppose having that object in view.

6616. That is to say, those gentlemen being special mammalogists, or special ornithologists, or special entomologists, are considered to be the fittest possible persons to give merely elementary lectures upon their particular subjects?—There is no question of the consideration of comparative fitness at all in the matter, but the gentleman who has charge of the department in my humble opinion would be most likely to give a satisfactory course, a course having that aim which I have spoken of and have in view.

6617. From the nature of the instruction the course would, I presume, be the same year after year?—He would not be tied down by any definition; it would be left to his judgment.

6618. But how could the teachers in the elementary schools be benefited by that year after year, unless the course of lectures were substantially the same?—Because science advances and changes its front.

6619. Does science advance so very fast that the schoolmasters of the elementary schools require a separate course of lectures every year?—That is a question which I think the Commission will hardly call upon me to enter upon a discussion of. I beg leave to ask whether that abstract question is one which I can be fairly called upon to answer. I have given you all the information that I think can be profitably given on this matter.

6620. With respect to the question of a typical exhibition, or an exhibition of a typical series of specimens, did you propose, in your original plans, to exhibit the whole of the specimens of insects that you might possess in the Museum?—I conclude my Report of 1862 with these words: "In the fulfilment of such aims, however, the principle of selection might and would still guide the arranger of the several classes in the proportionate space which I have estimated should be allotted to each." If any conclusion can be drawn from that, it must be the conclusion that the writer of it does not recommend that the whole of any class should be exhibited, but that the principle of selection should guide the arranger. Then I go on to say, "And in conclusion I would remark that such space once being provided for, a consistently proportional display" (that is more for one class and less for another) "of every class, giving a comprehensive view of the entire range of Natural History from man to the mineral, the increase of exhibition space would not need to keep pace with the increasing number of the added species of the several classes; the stored proportion of specimens would increase with the increasing number of known species; and this at least is certain, that such a necessity for space as now presses would never recur."

6621. Will you be good enough to inform the Commission how far this principle of selection differs from the principal of typical exhibition?—If you will define what you mean by "typical exhibition," I may perhaps be able to give you an answer.

6622. What I mean is selection?—But you do not give any principle of selection.

6623. The principle of selection is to take those specimens which exhibit the most clear and distinct

R. Owen, Esq.,  
M.D., F.R.S.

13 March 1871.



R. Owen, Esq.,  
M.D., F.R.S.

13 March 1871.

and certain modifications of form throughout the group; the principle of typical selection is quite well understood. Will you define what you mean by selection, and on what principle you would make your selection?—Having some regard to the time of the Commission, I think I must beg leave to decline answering that question off hand.

6624. Is it impossible to answer that question briefly?—If anyone will tell me what he means by a type, I can perhaps get some groundwork or stand point for an answer.

6625. That is not the question at present. You have told the Commission that you propose, and always have proposed, to follow the principle of selection in displaying specimens in your museum. I now request you to be good enough to inform the Commission what you mean by that principle of selection?—That would be better illustrated by seeing the way in which it has been put in practice. I should recommend the members of the Commission to go to our galleries and see what we do exhibit, and then go down and see what we keep in store. I should be most happy to give every assistance to every member who may visit our museum, that he may judge for himself what the principle is.

6626. Can you state that there is any difference whatever between the principle of selection, which you advocate, and the principle of typical exhibition, which you have just been condemning?—That depends upon what a naturalist may mean by a "type."

6627. But having condemned just now the principle of typical exhibition, you must have been aware, I presume, of what you were condemning?—With reference, for example, to the Tapirs; one species is South American and another is Sumatran; then there are two others that are found in South America; they differ in colour and in some other respects. Which should be selected for exhibition as the type Tapir? One naturalist says, "Exhibit the type Tapir, and put the others, as Mr. Gregory suggests, in drawers or in some out-of-the-way place." You will observe that in my Report I refer to classes and groups of animals as affecting the curator with reference to what he exhibits differently in different classes, and that which will apply to insects, for example, will not apply to Tapirs. We want, besides showing the Sumatran Tapir to the public, to give the zoologist the means of determining the specific characteristics of the Tapirs which perhaps may have been brought from the Andes or from Central America. I say that practically the Curator of the Museum would exhibit every one of the known species of Tapir, for this reason, that if its skin were doubled up and put into a store-room, it would be much more difficult for the zoologist to study, and to have the stiff folds pulled out to exhibit it, than if it were well set up in a more convenient place in a good light, where he might go from one tapir to the other to compare them. That is an example of the grounds on which I would exhibit the species of *Tapirus*, in the absence of any definition of the type Tapir. It is true, my friend Dr. Gray adopts this arbitrary mode of defining the type Tapir. The type Tapir, he says, is that tapir which was first called *Tapirus*. That is a common definition of a type animal; it is that type which has first received the generic name—it is the type of the genus. But it is frequently found afterwards that there are a number of species that agree with each other more in exemplifying the generic characters, and that the one first seen is perhaps the most aberrant in the group—it may be a group of 12, and it is the twelfth that is the most aberrant, whereas there are 3 or 10 in the middle part of the group that really are what, in another point of view, may be called more typical of the genus. You must observe that to a Commission having for its view the advancement of science, what a waste of time it must be to go into these abstract zoological questions.

6628. I think it is for the Commission to decide whether it is a waste of time or not. I must now ask you, supposing you had to exhibit the whole of a class

of the group Rodentia, whether you would apply that principle of selection to that group?—Unquestionably.

6629. On what grounds would you make your selection?—I should make the selection by exhibiting, for instance, the genus *Mus* as it is now restricted. I think I should select those that had the dental, and the digital, and other external characteristics of the genus *Mus*, in the best and least variable form, and then I should put also into the exhibition some of those that having those characteristics which led to their being referred to the genus *Mus*, yet still were remarkable for their large size, or, perhaps, for an unusual length of tail, or it might be for some very definite and striking peculiarity of colour, having in view always the three or four aims of a National Collection.

6630. In other words, you would select what you would consider types?—No; certainly not. I should select, besides the type, those that would be most striking and interesting to the general visitor. I would not only exemplify what you may call the type of the genus, supposing you have a definite idea of it, but its most remarkable variations.

6630a. I gather that you stated just now that the type collection which you said, or as I understood you to say, would be formed in the new museum, would give all the information that visitors could require?—No; certainly not. I expressly stated that my type museum would only be considered as conveying elementary information of the leading characteristics of the leading groups.

6631. I wish to ask whether my impression is correct, because the words, as I imagine, which you used were these: the type collection would give all the information which visitors could require?—That must be a mistake.

6632. Do I rightly understand you that you are completely satisfied with the internal arrangements of the Museum as the plans are now placed before you?—Perfectly.

6633. Is the arrangement of the plan for the interior of the Museum now the same as it originally was, or has it undergone a modification in consequence of the representations of the present officers of the British Museum?—Several modifications were made before we finally came to a general agreement and understanding. The modifications which I spoke of were modifications which were approved by the architect as not involving any direct contravention or breach of the main principle, and not attended with any increase of cost.

6634. Have you any opinion yourself as to the best way of making the collections accessible at once to the public and to the students, so as not to shut either out from examining them when necessary?—My experience is that the best way of making the collection useful for the scientific investigator and student is to have a room where the specimens, with regard to a special subject, can be brought to him to compare. That is my experience of that which scientific visitors best like. They like to be uninterrupted by general visitors, to have a room to themselves, a good light, and to have brought to them from time to time as many specimens as they may wish to compare, and for those rooms I have insisted strongly, from the commencement, that there should be ample provision with a good light, and for the artists also.

6635. Unless I am misinformed, a plan was submitted to the Trustees in which intermediate galleries for storage purposes were placed between the principal galleries; was that plan accepted or rejected?—I do not know anything about such a plan.

6636. Did it never appear upon the plans that were submitted?—I do not know at all to what you are now alluding.

6637. I think in that plan (*handing a plan to the witness*) you will see there is a provision made for intermediate galleries, which are marked of a light colour between the principal galleries; is that the plan which is finally approved of?—I see it.

6638. And those light spaces mark intermediate galleries between the principal ones, do they not?—



I would suggest that, with reference to those plans, you would get much more definite and practical and useful information from the architect. He will be able to tell you, because we never can be quite sure. We may have finally determined, and that determination goes with our Report—our report is received by the Trustees—then the Trustees have to communicate with the Board of Works, and the Board of Works have to communicate with the Treasury. There may be circumstances which we know nothing at all about, and they come back based upon very different views, and views which I have no doubt must be taken into consideration, and therefore I should be very glad, if you will permit me, to refer all questions upon the plans to be settled by the architect, because he knows exactly what our final views were, and those final views are embodied in the Reports of which I have spoken, which no doubt will appear in print.

6639. (*Sir John Lubbock.*) But are those your final plans?—I should have to go over a great deal of complex matter again, for they were finally determined after full study. I am very willing for the present to cast it out of my head till we get finally at work. This is about the sixth set of plans of the Museum that I have had to consider and go over from the time we began, and I must observe that all of them are according to the main principle of that Museum of the College of Comparative Anatomy which was built by Sir Charles Barry, 40 years ago nearly, for the College of Surgeons after my appointment there, and which superseded the old museum building, which I found when I first took service there. The old museum was a building of very great architectural pretensions, but, giving us the minimum amount of accommodation for display, and the minimum amount of light too, it was finally determined to do away with it entirely, and the Council most prudently put the matter of the new museum entirely with the architect, Mr. Clift, and myself, and out of that arose the museum of the College of Surgeons, which is lighted at the angle between roof and side-wall, and in which I think we have the maximum amount of light, and the maximum amount of exhibition room. The principle of this plan of lighting has been adopted for the museum in Jermyn Street. I have always insisted upon that in the first instance as the basis of the plans for the Natural History Museum. It was accordingly adopted by Mr. Hunt, and afterwards by Captain Fowke, and afterwards by Mr. Waterhouse, and has finally issued in the plans now before you.

6640. So far as those intermediate galleries go, that is a matter rather of principle, and I should like to know whether you approve of them?—Those spaces might be utilized rather as store-rooms, or as preliminary arranging rooms, and comparing rooms; they would not be those to which the public would be admitted.

6641. (*Professor Stokes.*) You mentioned a considerable number of subjects on which you conceive that lectures might be given—the staff of lecturers, supposing it to be the same as at present, would be only four, I think, or five if you include yourself?—Yes; for example, the gentleman who would hold Dr. Gray's position, as Keeper of Zoology, I think it most likely would take Mammalogy, but he might choose any subject; but then there is an Assistant Keeper who has special charge of the Ornithology, that gentleman at present being Mr. George Robert Gray. There is a Senior Assistant, who has special charge of the cold-blooded animals, reptiles, and fishes; that is Ichthyology with Herpetology—that is Dr. Günther, than whom no one could give a more satisfactory course of 24 lectures without in the slightest degree interfering with his curator's work. Then we have first-rate entomological senior assistants, in Mr. Fred. Smith and others, admirably adapted to give elementary lectures in entomology and the economical relations of insects, and so forth. We have in Dr. Baird, a gentleman who has special charge of the shells, and who could give lectures on Malacology. We have in Mr. Kent, a gentleman admirably qualified for giving

elementary instruction on the Zoophytes or Radiata, and who I hope soon will be a senior assistant; so that we have in each of those classes gentlemen who are experts in their several sciences. Mr. Carruthers, who has given excellent lectures at the Royal Institution, could give lectures upon Botany—Professor Maskelyne, who has long given lectures at Oxford, could give lectures on Mineralogy. I have no doubt that Mr. Waterhouse, or at all events the gentleman in charge of the Geology, would be able to give a course of Palæontology, but that science will probably be divided, and we should have probably a course of Vertebrate Palæontology, and another, which Mr. Woodward would be adapted to give, on Invertebrate Palæontology. All these things would grow out *pro re nata*.

6642. Would you make it essential that every assistant curator should be able to give a course of lectures, if it were required?—I should make it essential before any junior assistant was appointed as senior assistant, to the special care of any particular class or group of classes, that he should as a duty be capable of giving the limited number, as it may seem, of 24 lectures: so limited in order to meet the, no doubt in many respects, well-grounded objection of my excellent colleague, Mr. Winter Jones, the fear, viz., lest this giving of lectures should interfere with the direct work of the conservatorship.

6643. (*Dr. Sharpey.*) Do you attach much value to local museums as a means of creating a taste for science and for promoting the study of it?—They are of great use in that relation in the large towns.

6644. I forget whether you were on the Committee in 1856, to whom a question was referred by the Royal Society—a question that came before Parliament, in fact, respecting the position of science and men of science in this country, and the means of promoting science. That Committee consisted of the Royal Society, and those associated with them in the Government Grant Committee, and in one of their Reports they introduced the recommendation that duplicate specimens from the British Museum and other institutions supported at public expense be distributed to provincial museums?—I believe I was on that Committee.

6645. That recommendation was handed in to the Prime Minister, of course among many others; but we had heard in evidence that the British Museum rather declines to accept of the duplicates, from the incumbrance that they occasion and the trouble of preserving them; but do you think it would be at all feasible for the Museum to accept all the duplicates that are offered to them, and rather to encourage more to be sent, particularly from the Admiralty and other public departments, and to distribute them to the local museums, because I presume that you know better than I do that a local museum sometimes is well supplied with a particular series of specimens, and very ill supplied otherwise; and sometimes there are very good detached specimens, but unconnected with each other, and by a very moderate addition these blanks might be filled up, and the collection rendered more systematic and more representative and useful. Do you think that any sort of agency could be established through the British Museum for effecting that purpose?—You have exactly expressed what has been frequently passing through my own mind in connexion with duplicates. I have always looked forward to the realization of some such plan as that for our Natural History collections. We cannot do it in our present condition satisfactorily, but with those very small intermediate galleries that have been pointed out, there are conditions of space which would enable us first to determine (and it is a very difficult thing to do safely) what we can put aside as duplicates, but that unquestionably will be, if I am spared to go on with this work, one of my first duties when we get space enough and light enough. Then that space would enable us to press upon the Admiralty not to allow collections obtained by public money to go into private hands, but to be sent always in the

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M.D., F.R.S.*

13 March 1871.



*R. Owen, Esq.,  
M.D., F.R.S.*

13 March 1871.

first instance to the British Museum, which would put aside all the duplicates to go to other museums in the ratio of their importance and utility; for example, to Oxford, Cambridge, and other teaching exhibitions in the first instance, and afterwards to local and provincial museums; but unquestionably that would be one and I believe a very important work of a national collection of Natural History in the diffusion of the means of teaching by specimens.

6646. Might not local museums be classified according to the importance of the locality?—Yes, that would be so.

6647. And they would be supplied with, in some cases, a larger and more full collection, and in others with a smaller collection, but still a useful one for instruction?—Yes, there are a number of local museums in the metropolis, such as at the east end, and in other parts, which would have great claims to such duplicates.

6648. That would be naturally one great desideratum in the teaching of science; that is, teaching from the actual subjects themselves, in place of merely from a book, in places where the students could not meet with that opportunity of doing so?—Precisely so.

6649. (*Professor Stokes.*) Supposing the distribution of duplicates to local museums were carried on pretty extensively, do you think that that would involve much addition to the staff of the British Museum?—I do not see the conditions for much addition at present.

6650. It would not take up too much of the time?—No, I think not, at least the duplicates are not now so numerous and extensive as that.

6651. (*Dr. Sharpey.*) But there would be no hindrance to putting additional strength in if it became important?—There is no doubt that it requires a great deal of exact technical knowledge to determine upon a duplicate, and the longer you live and the more experience you have, the more cautious you become in finally determining what is a duplicate. That has happened in another department of the Museum with

reference to printed books, because some books have been considered to be duplicates; but a bibliopole attaching an artificial value to some title page for example, that may have been changed and put into one edition, perhaps letters in red in it and not in the other, finds out that that is not a 'duplicate.' Circumstances of that kind have led to very great reticence and care in pronouncing about duplicates. With regard to fossils, which are frequently fragmentary, it is extremely dangerous to give away a thing on the idea of its being a duplicate, for it may show a little character which the others do not: but all that requires very careful looking into, and would be a condition of requirement of more service.

6652. But the determination having once been made it might be the duty of some competent person then to assign them to the proper locality which stood most in need of them, or where they would be most useful?—Yes.

6653. (*Sir John Lubbock.*) I rather gather from what you have said that the labour of determining whether a specimen is a duplicate or not is really the principal labour?—Yes, that is labour which must, of course, be done by the head of the department generally, who thoroughly knows what he is about.

6654. Supposing a collection is sent to the British Museum, when you have determined which specimens in that collection are duplicates and which are not, you have practically completed the heaviest labour that you have to deal with, have you not?—Quite so.

6655. It is not so much the dealing with the duplicates, as the determination of the duplicates, which is the difficulty?—Exactly so.

6656. (*Chairman.*) Is there anything else which you would desire to state to the Commission?—I do not think there is anything else except my strong desire from my past experience of the effects of Commissions and Committees that there should be no unnecessary delay with regard to carrying out the plans.

The witness withdrew.

Adjourned to to-morrow at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Tuesday, 14th March 1871.

PRESENT :

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, BART., IN THE CHAIR.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D., Sec. R.S.

HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

JOSEPH D. HOOKER, Esq., M.D., C.B., F.R.S., examined.

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14 March 1871.

6657. (*Chairman.*) Will you be good enough to describe the office which you hold in relation to the botanical establishments at Kew?—I am Director of the Botanic Gardens both as a scientific establishment and as a place of popular resort; of the Herbarium, the Library, and of the Economic Museums.

6658. Will you be kind enough to describe to the Commission the nature of the scientific work which is turned out from the Herbarium at Kew?—It is partly public and it is partly private. It is public in so far as this, that for about 40 years the Herbarium now at Kew has been the recipient of almost all collections made by Government Expeditions, and the chief recipient of contributions from the herbaria of Continental museums, and of both British and Foreign travellers. It has furnished during this period materials for the publication of about 140 volumes on botanical subjects, many of these being accounts of plants collected by Government Expeditions, monographs published by officers connected with the Herbarium, colonial floras, and works of that description. Some

of these have been paid for by the Government, some issued at the expense of the author, others at that of the publishers.

6659. Besides which I apprehend there have been monographs on subjects of interest?—Yes; various monographs have been chiefly published in the Linnean Transactions.

6660. What have been the relations of the Museum at Kew with the British Museum?—They are competing bodies; but hitherto the chief Government collections have been sent to Kew.

6661. Has there been insufficient space in the British Museum for the reception of specimens and the enlargement of its herbaria, or has any other obstacle interfered?—With regard to the British Museum I do not think any person can answer that except the officers of the establishment. I do not think that the nature and extent of its botanical collections, or their condition, is well known except to its officers.

6662. Will you describe the nature and extent of the Museum at Kew?—Of museums proper, apart from



the Herbarium, there are three; they were designed primarily to demonstrate to the public the uses to which plants are put, by exhibiting specimens that illustrate useful plants, maps showing their distribution, diagrams showing their structure, and specimens of the products which they afford. They are arranged scientifically, according to the Natural System, and, as far as they have been procured, all the products of the plants are shown. At the same time it is the receptacle for all specimens that are not fitted to be kept in an herbarium; for instance, there are many fruits and seeds which are interesting from their structure or from their appearance, but which, though they are not of economic value, are placed in the museums, because they could not be put into the herbarium. Thus the museums serve a double object. They are ancillary to the herbarium in containing specimens not fit to be placed in the herbarium, and they are instructive to the public, inasmuch as they show the uses to which the plants of all natural orders are put.

6663. What are the relations of this Industrial Museum to that which exists at South Kensington?—Hitherto there has been no competition between them, as far as I am aware; for the Museum at South Kensington contains chiefly manufactured articles arranged according to their uses. For instance, in Kew the fibres used for textiles are arranged under the Natural Order to which each belongs; the European flax going into the case illustrating the Natural Order to which the flax plant belongs; the New Zealand flax under another order, and the hemp under a third; but in South Kensington all the flaxes would be brought together. Further, South Kensington exhibits extensive series of manufactured articles, whereas at Kew little is shown beyond the raw product, and one or two manufactured articles to attract public attention immediately to its uses. South Kensington, as I understand it, affords a complete illustration of the uses of vegetables as applied to art, arranged under their applications.

6664. Could you give the Commission information as to the charges of the staff of the Museum at Kew?—The museum collections occupy three buildings. I may say that we prefer three buildings to one building, because of the immense numbers that visit the establishment in summer, and the consequent crowding around attractive objects like the museums. For the three museums there is one Curator, who has a maximum salary of 150*l.* a year. The scientific arrangement of the museums devolves upon myself and upon the Keeper of the Herbarium and Library, who is my principal scientific aid in the establishment. He has a salary of 400*l.* and a house, and he has two assistants and a clerk; that is the whole of the scientific staff of Kew.

6665. Has anything yet been done in the way of illustrative conversations or lectures to persons visiting, or to particular or special classes visiting, the museum?—Nothing.

6666. Have any special applications at any time been made from working men's colleges or other societies for mutual instruction, expressing a desire to avail themselves of such methods of instruction?—Only twice that I can remember.

6667. Do the tickets give any detailed information concerning the plants?—They generally give as much detailed information as is likely to be read, and this sometimes is very considerable. The Board of Trade returns of the quantities introduced during the year of sugar, coffee, spices, and so forth, are given, the countries from which these products come, their native names, as far as we can ascertain them, and very often interesting information culled from books of travels.

6668. There is also a Scientific Library at Kew, is there not?—Yes, that is in the same apartments with the herbarium.

6669. Is that chiefly a library of reference for students?—It is entirely a library of botanical reference.

6670. Is Kew much resorted to by foreign botanists?

—Very largely. No botanical monograph is considered complete which has not been worked up with the materials at Kew.

6671. So that the botanical societies throughout Europe and the civilised world are more or less in relation with Kew?—Yes; we are in communication with almost every body of the kind, in America, India, and in the Colonies as well as in Europe.

6672. I presume both for the purpose of exchanging specimens and likewise for communicating the latest observations in botany?—Yes.

6673. Could you state with some approach to accuracy about the number of foreign students who resort to Kew in the course of a year?—We do not take into account those who come for a day or so, but of working botanists who come and stay for some time at Kew, there are sometimes as many as 20 in a year, and when one comes he very often does duty for several others.

6674. Has it been at all the practice of the department at Kew to distribute duplicates to the local museums in England?—We never have had applications from local museums in England for specimens of plants from the herbarium, and to a very limited extent indeed from the museums. We occasionally have applications from professors for duplicates of tree-fern stems, and objects of that description, and these are complied with when possible.

6675. From the resources which Kew has at its disposal, or might have, from marine expeditions and other sources, do you think that if a system of distribution were organised at the Government establishments, Kew could supply, supposing such a desire to arise, any considerable number of duplicates?—I should think very largely. The difficulty is in making application at the right time. Hitherto duplicates have been distributed as fast as possible, because they take up a great deal of room and encourage insects. My plan has hitherto been, whenever I receive a collection, whether from a Government Expedition or from a private source, to have it at once named and catalogued, the first complete set deposited in the herbarium or museum, and the duplicates distributed.

6676. Two things would therefore appear to be necessary, some means by which the local wants should be ascertained by persons properly qualified, and likewise a constant knowledge of the means which the Botanic Garden Museum at Kew has of supplying those wants?—Yes.

6677. That could be accomplished by an Inspector of Museums?—It could be easily accomplished by such means. The demand for botanical objects would be always very small, and confined to such as are striking or attractive, whilst a vast number of economic products such as local museums would want might be bought anywhere, as cocoa-nuts, sugar, rice, starch, and so forth. Special objects like sections of tree ferns, or rare woods, would be rarely sought by local museums, but there would be no difficulty in supplying them.

6678. You are aware, however, that in the north of England there are what are called naturalists' societies, composed of men really very anxious to improve themselves in the study of botany among other subjects?—Yes.

6679. And if a well-ordered museum existed in which the various blanks were from time to time supplied, so as to have a complete series of specimens for consultation, might not such a museum situated in a populous district be of great use in cultivating a knowledge of natural science?—As far as herbarium specimens are concerned I think it should be almost confined to a collection of local, or at most British plants. I do not think that there is any prospect of a general herbarium being valued even in populous districts; but a typical herbarium might be useful.

6680. As to your accommodation at Kew, is there anything you feel to be urgently needed there for the progress of the museum?—At present the herbarium is accommodated in an old house that is not fireproof.

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The collection being the most valuable in the world, illustrating the rise and growth of systematic botany during the last half century (because of the enormous number of typical specimens which it contains), should be accommodated in a fireproof building.

6681. Carrying your mind from the establishment at Kew, you are probably aware that a project has been put forward for the transference of the Natural History collections of the British Museum to South Kensington. Have you any suggestions to make in relation to that project?—I think it would be of very great importance if that were done, that the British Museum and Kew should be no longer in any sense competing bodies, but that they should be brought into harmonious relations, and each made ancillary to the other.

6682. Would you contemplate any separate function for the two museums, or that they should have common functions?—Yes; certain separate functions to a great extent.

6683. Have you in your own mind conceived what would be the proper distribution of duties between the two museums?—With regard to one very important branch of botany, the palæontological, I think it would be best that it should remain in or near London, it being as essential to geologists as to botanists. It requires illustration by an herbarium, but not by an herbarium of the extent and description of the great Kew herbarium, which would be extremely cumbrous to use in relation to a palæontological collection. Wherever that palæontological collection is, there ought to be a good herbarium, and I think it would be very advantageous if, instead of being arranged as the Kew herbarium is, primarily upon botanical principles, it should be primarily arranged geographically. It would be a very great advantage, to persons coming from Australia, for instance, and bringing plants which they wished to know something about, if they could consult a local collection of Australian plants, and thus name their specimens by simple comparison. Such an herbarium would, I conceive, be also more useful to the palæontologist, because the key to fossil botany is very much a geographical one. There should also be with the palæontological collection special collections of recent fruits, leaves, &c., directly illustrative of known fossil plants, and placed along with them in their cases.

6684. Besides, therefore, the transference of the collection of fossil botany to South Kensington, is there any other change which you would desire to make in the Museum at Kew?—No. I would still keep Kew as the great scientific working herbarium, to which, as hitherto, all botanists must come; and I think that the Herbarium at the British Museum should be named comparatively and consistently with that at Kew.

6685. You would contemplate, therefore, that the two establishments being ancillary should be under one common head?—I think that the two herbaria should be rearranged under one head, and be brought under one system of management.

6686. And that the several officers should work in harmony under the superintendence of the Directors?—They should in future work in harmony, but the two Herbaria should be under the direction of the heads of the establishment at Kew and of the new Natural History Museum at South Kensington respectively.

6687. Can you describe any separate functions which the Museum at South Kensington might fulfil, which you would not expect to be fulfilled by that at Kew?—I think that a herbarium affording the ready and rapid means of naming plants would fulfil one function, and the use of the same for the purposes of the palæontological collection a second; and I think that there ought to be besides this, at the British Museum, an instructional botanical collection for public exhibition, which would show the relations of plants to one another, their structure, and the functions of their organs; and illustrate by drawings and dissections of flowers, woods, and fruits, &c., the general features of the Vegetable Kingdom.

6688. Would you think that any scheme of instruction, such as that which was adverted to in a previous part of your evidence, would be more likely to be successful at South Kensington, from its vicinity to London, than at Kew?—I have no doubt that it would be more successful at South Kensington, not only from its accessibility, but from the nature of our climate, which would render it difficult to collect an audience at Kew.

6689. (*Professor Huxley.*) Will you be kind enough to tell us what is the relation of the Director of Kew Gardens and the whole establishment there to the Government?—I am immediately responsible to the First Commissioner of H.M. Works.

6690. Do you make your Report to him?—Yes, annually, and I address all letters to him.

6691. You have at Kew nothing like the Body of Trustees which exists in connexion with the British Museum?—None whatever.

6692. Do you think it would be advantageous to have any such body in connexion with Kew?—No, I think not. There would not be the same objection to a Board of Visitors if that was thought necessary.

6693. Of the same nature as the Visitors to the Royal Observatory?—Yes, so far as I know their position and functions.

6694. What power would you give the Board of Visitors?—The power of recommendation to the First Commissioner of Works, after consultation with the Director.

6695. I presume that you would hardly like to have the power of making appointments taken out of your hands and placed in that of a Board of Visitors or Trustees?—No, that would not work.

6696. Not even if that Board of Trustees had such distinguished persons on it as the Archbishop of Canterbury and the Speaker of the House of Commons?—No.

6697. Are any lectures given at Kew at present by any of the officers of the gardens?—Lectures and demonstrations are occasionally given to the young gardeners, but this is voluntary on the part of the officers.

6698. Do you think that it would be possible for the officers of the gardens to combine the function of giving public lectures together with their present duties?—I think it would be possible for certain able and active officers to do so, but I think that it would be highly inexpedient to require it of them.

6699. I presume that the business of conservation and naming of plants is one which is quite sufficient to occupy a man's whole time?—Yes, to keep him abundantly occupied.

6700. And a man might be an exceedingly good namer of plants and a very accomplished botanist, but perhaps he might be a very imperfect expositor?—A very inefficient one.

6701. I suppose you look upon your Herbarium as a sort of object library?—Yes.

6702. And there are persons who consult it in the same way as they consult the Library of the British Museum?—Yes.

6703. You are aware that the Government has now decided upon removing the Natural History collections to a new museum to be built at South Kensington?—Yes.

6704. You are doubtless acquainted also with the present government of the British Museum?—In a general way I am.

6705. That there is a Body of Trustees who are the ultimate authorities; that under them there is the Principal Librarian, who is their secretary and chief executive officer, and that under him again come the Superintendent and the officers of the Natural History collections?—Yes.

6706. All reports being made through the Principal Librarian to the Trustees, and the Trustees, being wholly independent of any direct Government control?—Yes.

6707. Do you think that it is desirable to retain that mode of government for the new museum?—Decidedly not.



6708. What plan would you adopt in preference ?  
—That there should be one Administrator or Director responsible to a Minister of the Crown.

6709. In the same way as you are responsible to the First Commissioner of Works ?—Precisely.

6710. What would you do with the Trustees ?—I should not retain them.

6711. Would you propose to retain in their hands any power of visitation ?—None whatever. The Government should appoint a Board of Visitors, if a board of visitors were determined upon, from persons with other and very different acquirements.

6712. Upon what principle would you select the Board of Visitors ?—I should select accomplished naturalists, and at the same time persons of some practical experience in administration.

6713. And you would give them no power of direct interference, but only one of representation ?—Only of representation to the Minister, after consultation with the Director; giving that officer, however, no power to prevent the Visitors making what communications they pleased to the Minister, so long as these had been previously laid before him.

6714. I presume that you would give the Superintendent of the new museum the same sort of authority over the Keepers of the departments that you have over the officers at Kew ?—I think that, subject to the Minister, the Director's power should be absolute.

6715. Do you think it desirable to connect the function of teaching with the duties of the Curators or Keepers in the new museum ?—In no respect.

6716. Having regard to the extent of the different departments of Natural History now, would it not be somewhat difficult for a man to keep himself on the level of information about systematic zoology, and at the same time spend any considerable portion of his time as a public expositor ?—I should think it would be quite impossible.

6717. Have you any ideas as to the mode in which Natural History objects, such as zoological specimens, may best be displayed to the public, so as to allow of the uninterrupted access of the public on the one hand, and of the uninterrupted access of men of science, or persons who wish to study the collection, on the other ?—I once published a suggestion to the effect that it would be a good plan to have spacious galleries in which the specimens should be arranged in cases hermetically closed in front towards the public, and accessible to working naturalists at the back.

6718. As an experienced Curator of a museum yourself, do you see any practical objection to arranging the specimens in such cases ?—None whatever. It requires a little management here and there. You require a double set of tickets. For instance, objects in bottles would require a ticket behind as well as in front; but whereas the ticket in front would contain a good deal that was useful for the public to know, the ticket behind need only contain so much as would lead the curator or worker to the object.

6719. We have been informed that there was absolutely a physical difficulty in putting specimens in cases under those circumstances; do you see that difficulty ?—No. It is not quite so convenient to arrange from the back as from the front, but those specimens which I suppose would be the exhibited ones would not be those most required for study; to a great extent they might consist of duplicates.

6720. And the arrangement once made would therefore last for a very long time, except with occasional changes ?—Yes.

6721. Are you much troubled with dust at Kew ?—Not at all, compared with London.

6722. You are aware of the impediment that it is to keeping specimens in museums in London ?—Very great; but I think that might be obviated to a great extent by placing the museum within a grassed area planted with trees.

6723. Still wherever you might put your Natural History Museum there is no doubt that if you have thousands of persons walking through it, those persons will create an enormous amount of dust ?—Precisely

so; but I question whether that amount is so great as what the atmosphere otherwise brings, especially in cases where the road or open street abuts on to the building. The quantity intercepted by grass and by trees, if you can have them, is very great.

6724. I have no doubt that you have observed that the main process by which the dust is got into the cases in which specimens are exhibited is the sort of pumping arising from the alternate heating and cooling of the air, as the result of which the dusty air in the interior of the building is pumped into the cases and the dust is deposited upon the specimens ?—Yes.

6725. I suppose that you propose your plan of hermetically sealing the face of the case which is turned towards the public mainly with a view of preventing that pumping operation ?—Yes, mainly for that, and also for the greater convenience of working naturalists, who are thus not interfered with by the public when getting access to the specimens.

6726. There would be nothing, would there, to prevent a museum so arranged being open to the public every day all day long ?—No.

6727. On the other hand, the Curator and persons who wished to work at the specimens could always get at them every day and all day long without interference ?—Yes.

6728. What do you do with duplicates, if you have any ?—I generally keep a list of the establishments to which each class of duplicates will be most useful, and distribute them very much accordingly. Sometimes there are as many as 25 or 30 sets of duplicates in one collection, and, so far as the specimens are concerned, we distribute them ticketed with a name or number corresponding with the name or number they bear in the Kew collection, so that each specimen is the authority for Kew.

6729. (*Professor Stokes.*) I presume your time is very fully occupied at Kew ?—Yes, it is.

6730. Supposing that in addition to your present work you had thrown upon your hands the superintendence of the botanical collection in the museum which it is proposed to erect at South Kensington, would you not find that you had more than you could do ?—I think that with the aid of the museum officers I could bring the collections under one system. There would be a good deal of assistance required in the first arrangement, but after that I think it would simply be the duty of one establishment to supply the other with specimens.

6731. You have sent specimens to foreign museums. When the specimens are sent, of course there is an end of your trouble ?—Yes.

6732. But if you are to send specimens to the Professors of the museums at South Kensington, and have the further responsibility of arranging them, or directing the arrangement when they get there, would not that give you too much work ?—The arrangement of the herbaria once effected, the trouble of supplying the South Kensington Museum with specimens would be very trifling. On their arrival at the British Museum they could be put into their places by the officers there, the operation being as simple as that of putting books on a shelf.

6733. Then you think that a subordinate working under you would be sufficient for arranging the botanical part of the South Kensington Museum, for keeping up its herbarium ?—After the first re-arrangement was effected a subordinate at the museum could intercalate the additions; but if you keep a palæontological collection at the British Museum you must have a good botanist there at any rate. I think it would be a great pity that there should not be resident in London a good botanist, in connexion with the Natural History Museum; and such an officer, who would have the charge of the fossil botany, would be fitted to take charge of the herbarium there too.

6734. (*Professor Smith.*) Do I rightly understand that you would propose that the Botanical Department of the Museum at South Kensington should be placed under the control of the Director of Kew ?—I do not

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say that the two botanical departments should be under one control, but that the two herbaria should be managed upon one system.

6735. Would it be your idea that the two institutions, the Museum at South Kensington and that at Kew, should be under one direction?—The formation of the two herbaria should be under one control; when formed, the South Kensington herbarium would remain under the control of the botanist attached to the Natural History Museum, and be continuously added to from Kew.

6736. With regard to the palæontology, have you a distinct opinion as to whether it ought to be placed with the Botanical Department?—Undoubtedly the fossil plants ought to be in the Botanical Department of the Natural History Museum. I think that the Palæontologist (vegetable) should be supplied with a complete, well-named, geographically-arranged collection of plants.

6737. (*Professor Stokes.*) Would you propose to divide the Palæontological Department at South Kensington into two divisions, animal and vegetable?—I think so, decidedly.

6738. Under two distinct heads?—Yes.

6739. (*Professor Huxley.*) That is to say, you would put the animal part under the Superintendent of the Natural History collections?—Yes.

6740. And the plant part under the common government of Kew and South Kensington?—No. As far as the fossil plants and herbarium are concerned, they should be under the direction of the museum authorities.

6741. Then you would keep the fossil plants under the Superintendent of the Natural History collections?—Yes, distinctly.

6742. But you would give the Curator of the fossil plants free access to the botanical collections, and he should be under the same head as Kew?—The fossil plants and herbarium of the museum should be placed in juxtaposition, and the keeping of both should devolve upon the same officer of the museum.

6743. Do not you think that under those circumstances there might be a little danger of a jar between the person who had the charge of the recent herbarium at South Kensington and the person who had charge of the fossil plants?—The person who had the fossil plants would also have charge of the recent herbarium. He would look to Kew to be supplied with herbarium specimens.

6744. But, as a matter of discipline, would you put him under the Natural History Superintendent?—Yes, distinctly.

6745. He would then simply draw his supplies from Kew?—Yes, that is all. It would be part of the duty of the first herbarium in the country to supply the British Museum with as complete and well named a set of herbarium specimens from the several geographical areas as possible.

6746. And those specimens once supplied to South Kensington would be in charge of the Superintendent of the Natural History collection and under his government?—Undoubtedly.

6747. (*Professor Smith.*) You would not propose to have an *imperium in imperio* put upon the Superintendent of the Natural History collections?—Distinctly not. The Director of Kew would be responsible for the new museum at South Kensington being supplied with everything that Kew could supply, the object being defined, namely, the keeping up of a thoroughly well-named typical set of specimens arranged geographically.

6748. Did I rightly understand you to say that you conceived the system of government at Kew to be one which might be with advantage transferred to the British Museum?—Yes. I think that the plan should be of having one supreme Director responsible solely to a Minister of the Crown.

6749. You have no doubt considered the very different magnitude of the two institutions?—Yes.

6750. Particularly in respect of the patronage that would be placed in the hands of such a Director?—

Yes. I am not quite sure that the difference is so very great. You would have in the British Museum more accomplished naturalists; but, on the other hand, you would have very much fewer temporary subordinate appointments of value.

6751. But more appointments of some value and importance?—Yes, certainly.

6752. Did I rightly understand you to say that at Kew there was under you but one office that might be described as an office of some importance in respect of emolument?—Yes, one; that is the Keeper of the Herbaria and the Library, and he has two scientific men under him.

6753. Those are places of a still more subordinate character, are they not?—Yes; but, on the other hand, I have garden officers, and I have labourers and gardeners in such numbers as you would probably not have in the Natural History Museum.

6754. The difficulty which I want to put before you does not consist in entrusting the nomination of any number of persons of that very subordinate class to the Director, but rather in entrusting to him the nomination of a considerable number of superior officers, such as the present Keepers of the various departments in the British Museum. You do not think that there is a difficulty in that respect?—I do not think that is any valid objection.

6755. Do you propose that the appointments should be made immediately by the Director, or by the Minister upon the recommendation of the Director?—Yes, of the Director.

6756. So that the responsibility would rest with the Minister?—Absolutely.

6757. And if they were canvassed in Parliament the responsibility would fall upon him?—Yes, as it now does upon the Trustees in the case of the British Museum, and of the First Commissioner of Works in the case of Kew.

6758. In Kew the upper appointments are made upon your recommendation by the Minister?—Yes, by the Minister, who obtains a warrant from the Treasury confirming the appointment.

6759. (*Dr. Sharpey.*) Did I rightly understand you to say that you did not think it was advisable that the duty of giving lectures upon the specimens under their charge should be imposed upon the Keepers of the different departments at the British Museum?—Yes, I think it would be very unadvisable that they should.

6760. But do you think in another aspect that it would not be advisable that some advantage should be taken in the way of illustration and lectures to the public of the specimens in the British Museum, whoever might be appointed to deliver those lectures?—That opens up an entirely new question, as to whether the Government should supply lecturers as well as supply museums, which I am not prepared to go into.

6761. (*Professor Huxley.*) There is, as you are doubtless aware, as a Curator yourself, a very great objection to having valuable specimens taken out and handled and knocked about and put back in the cases; but might not such an object as Dr. Sharpey describes be perfectly well served by using duplicate specimens?—That is a question of detail, and I should think it would be a very good arrangement to have a set of duplicate specimens to be lent out for such purposes under certain conditions and under certain guarantees.

6762. (*Chairman.*) I have understood you to suggest a great simplification in the government of the Natural History Departments by putting the Director of the department in immediate relation with the Government; does this not lead one immediately to the consideration of the question of there being one Central Department which had functions connected with instruction in science which might be called a Department of Public Instruction?—That is a question I should like to answer under some reserve. There are advantages in distributing such institutions amongst various Departments of the State.

6763. (*Dr. Sharpey.*) Under what Minister of



State would you propose to place the Director of the Natural History Department of the British Museum?—I am not prepared to say.

6764. (*Chairman.*) Have you considered whether, in relation to the contemplated transfer of the Natural History collections from the British Museum to South Kensington, it might be important to make any special arrangements with a view to their immediate classification and re-arrangement?—I should at once engage some person of scientific knowledge and of administrative capacity to report upon the whole subject, preparatory to its removal.

6765. And without that you would expect that very considerable difficulties, if not great confusion, would arise in the transfer of the objects?—I should think so. I am given to understand that a re-arrangement is required that will render the collections equally useful to scientific persons and the public; in which case it requires a complete re-organisation, and whoever has to conduct this should begin at once to form his plans.

6766. And that should be a person of special scientific acquirements, with great administrative power?—Yes, with great administrative capacity.

The witness withdrew.

PHILIP LUTLEY SCLATER, Esq., Ph.D., F.R.S., examined.

6769. (*Chairman.*) I believe you are Secretary to the Zoological Society of London?—I am.

6770. Have you considered, and can you suggest to the Commission, what you would conceive to be the best mode of government of the new Museum of Natural History which is proposed to be founded at Kensington?—Yes; it is a subject which I have thought a great deal upon. My belief is that it would be better to place it under the control of a Director, who shall be immediately responsible to some officer of Her Majesty's Government.

6771. Have you any objections to the present mode of administration by Trustees?—Yes; I entertain very serious objections to the present mode of administration. It must be recollected that at the present moment the collections of Natural History are in the same building and under the same government, as the large collections of Art, and the great Public Library; so that they are, by virtue of the Acts of Parliament which regulate the administration of the British Museum, under the government of a body of 50 Trustees. These Trustees are, some of them, the great officers of State, who have many other things to attend to; others are the nominees of certain families who have given certain collections to the Museum; and a few are nominated directly by the Crown. Of course, in the case of such a heterogeneous body as this, it is impossible that they can as a whole exercise any very direct influence on the collections under their charge, and, as is natural, their authority must in all cases be handed over principally to the person who is called the Chief Librarian, who is also Secretary to the Trustees. The Chief Librarian always having been appointed on account of his knowledge of books and literature, is certainly not a proper person to administer the government of a public collection of Natural History. No doubt he would not profess himself to be a naturalist, and certainly does not in the present instance, and, of course, it cannot be expected that he would be acquainted with the wants of a Natural History collection. Therefore, I consider that so long as the Natural History collections remain in their present position they are suffering from the want of having a proper administrative head.

6772. Would the objection which you entertain to this method of government be in any degree obviated by making the Director of the new museum, the Secretary, or executive officer of the Trustees for all purposes connected with the museum?—Supposing that the museum, as we believe is now determined, be moved to South Kensington, it would certainly obviate many of these objections if the Director of the new museum at Kensington were made Secretary to the Trustees *pro tanto*, but still you would not get the responsibility

6767. Without that you would not conceive that the transfer would effect the objects which it is intended to accomplish?—No, I do not think it could. It appears from what I know of museums, both British and Continental, that it would be a gigantic work. The Zoological collections of the British Museum are the finest in Europe, being the most important in point of nomenclature, in point of number of specimens, and in point of extent.

6768. Is there any other point arising out of the evidence that you have given which you would like to mention to the Commission?—The principles which I have laid down with regard to the Botanical Department I think are clear to the members of the Commission. I think all other points, as to what parts of the present botanical collections should remain where they are, and what parts should be re-organised, and what additions should be made to the South Kensington Department, are questions of detail, which would be entered into by the Director of the Museum, in conjunction with the present Keeper of the Botanical Department of the British Museum and the Director of Kew.

that you would if you put the Director under the control of some officer of the Government. The Trustees at present are an utterly irresponsible body; it is no use remonstrating with them, or appealing to them in any way, because the public has no hold upon them at all; they are not responsible to anybody for the administration of their collections, and, therefore, as a fact, it has been found that when complaints have been made they do not care to attend to them.

6773. To whom would you confide the appointment of the officers of the new museum?—I think that a collection of Natural History is a very different sort of institution as regards its management from ordinary institutions, because the qualifications required for an officer in a Museum of Natural History are of a very special character, and, therefore, I think, that to suppose that you would get any number of candidates for a particular office under the ordinary Civil Service rules would be a fallacy. It would be much better to leave the appointments, at any rate of the principal officers, in the hands of the Director. If you get an efficient Director he will know who would be the persons best qualified to fill the different situations, and it would be much better, at any rate, not to appoint any of the principal officers except with his full sanction, even if you do not leave the appointment directly in his hands.

6774. Would you have any form of control over the Director beyond his responsibility to the Government?—I think that a Board of Visitors would perhaps be a very good sort of control over a National Museum of Natural History. In the event of such a Board being contemplated, I should suggest that nominees from scientific societies in London, who are devoted to the various branches of natural science, should be constituted a Board of Visitors, who might visit the museum once a year and report thereon. Of course in that case the nominee of each particular society would see that his own branch of science was properly attended to in the museum: the nominee of the Linnean Society would probably see that the Botanical Department was fairly treated; the nominee of the Zoological Society would see that the Zoological Department was fairly treated, and so on with the Geological Society, and other societies. I think that would be a very fair scheme to put forward, and it would correspond to a certain extent to the visitation of Greenwich Observatory which takes place by the Royal Society every year.

6775. Regarding the Natural History collection as only one of many departments of scientific operation, have you considered with what department of the Government it should have its immediate connexion,

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14 March 1871.

or whether you would create some new department? —I have always understood it to be the intention of the Government, sooner or later, to appoint a Minister of Education, and, of course, I think that the museum ought to be placed under either the Minister of Education, or the person who, in the present Government, corresponds to that Minister; that would be, I suppose, the President of the Committee of the Privy Council upon Education.

6776. And probably you would anticipate that some scientific council, representing the several departments of science, should be associated with that Minister as an advising body?—I think that might be done, but I do not know whether that would be necessary more than it is in the case of Kew Gardens. I believe that the Director there has carried out his aims and objects in a very efficient way, and I do not see why the Director of the museum should not do the same without that sort of control.

6777. In the case of Kew Gardens the connexion with the department has been simple and single, but supposing it to be connected with a scientific department which became universal, and therefore multifarious, might not the utility of such a council be by that increased?—I think that individual responsibility is, as a general rule, better than divided responsibility.

6778. But the Minister, in the case supposed, would still be responsible to Parliament for all acts, and the Council would be merely an advising council?—I see no objection to that plan.

6779. What are the leading principles which, in your opinion, should be considered in the construction of a new museum of Natural History?—I think that one of the most important leading principles is, that some system of construction of the new museum should be adopted whereby the public can be admitted all day, and every day, to view the collections without interfering with the scientific work of the establishment, or with the special examination of objects by students. I mean to say that whereas with the present arrangement of the British Museum no scientific work can take place in the galleries except for two or three days in the week, some system should be adopted whereby scientific work can go on continuously every day, and the public be admitted at the same time to see the collections every day. Having for the last 20 years been in the habit of going to the British Museum, generally on Tuesdays and Thursdays, I seldom go in or out without seeing a group of people applying to go into the museum when it is closed. The effect of that is that they go away disappointed, and I think it is a very bad thing, because they go away disgusted, and perhaps will not come again. I think it is of great importance that a public museum should be open every day to the public.

6780. Will you describe how, in your opinion, the objects of scientific study and the opening of the museums to the public could be simultaneously carried out?—As far as I know there is only one plan by which it could be effected, and that is by arranging the exhibited objects in large wall cases, to which access is obtainable from the back by doors opening into workrooms adjoining the exhibition room. That is, supposing the exhibited objects to be arranged in a square public room, the public would be in the inside of the room examining all the objects through the wall cases, and the students' rooms would surround the square. Thus a student or any person wishing to remove any object might come in from the back and take the object away into the students' room, without going into the public room at all. There should be hermetically sealed glass cases surrounding the public room, and access to those glass cases would only be obtained from the adjoining students' rooms.

6781. Is any one particular form of building more suitable for this purpose than another?—It has always struck me that a hollow square would be the best form of building suitable for galleries of this kind. In such case I should build galleries all round the hollow square with the light coming from the outside, and I should place the students' galleries in the

inside of the hollow square, so that the students would obtain light from the inside of the hollow square, and the public would obtain light from the outside of the hollow square.

6782. Would you have the building one storey only?—In the system of lighting public galleries, which has been usually supposed to be the best, the necessity of top lighting has always been very much urged; but I think that by the system which I should suggest the top lighting would be done away with altogether, and therefore there would be no objection to having the building of two or three storeys, which of course would be a great economy as regards space.

6783. Do you think a library a necessary appendage to the museum?—I think that a library is of course quite a necessary appendage to a museum. There has been a great deal said about the inconvenience of removing the Natural History collection away from their present connexion with the National Library to a different situation, but I think that too much importance has been attached to this point. There is at present in the British Museum a great difficulty about getting books from the National Library; it is impossible for any student of the museum at this moment to get books from the National Library. He can go into the library and get his books, and he can go into the room where the specimens are and see the specimens. But there are no means at present of bringing the books and the specimens together, and therefore the library is really practically useless, except to the officers in the department. The only way of getting books in the students' room of the museum at the present moment is by the courtesy of the officers of the department. If you ask one of the officers who happens to be your friend he will send and get you the book you want, but to general students that is impossible, and therefore I consider that the importance of the connexion between the public library and the museum has been very much over-estimated. It would be much more convenient, in my opinion, to have a special library for the natural sciences attached to the museum. I should suggest that each department in the new museum should have a working library of its own, just as every department in the British Museum has now a special working library, and that there should be some large library arranged, perhaps in some central part of the building, to which access could be obtained from every department. I think also that the expense of buying that library has been very much overrated. I think that it could be got together for very much less cost than is commonly supposed. I say that, judging from the number of books that I require in the work which I have to do, which is principally in two departments of zoology, mammals and birds—I find that in the Zoological Society's library, which is by no means a large one, I get nearly all the books that I generally require, and I am constantly engaged in original work of all sorts, particularly upon these two branches of zoology.

6784. Do you consider a theatre or a lecture room also a necessary or desirable appendage?—I think it is not a necessary appendage, but it would be a very desirable one. The task of educating at all events the youth of the country in the natural sciences ought, in my opinion, to be carried out by the universities, and if that were sufficiently done by the universities it would not be so necessary to have the same sort of lectures go on in London; but under the present circumstances I think it would be very desirable indeed to have a staff of lecturers attached to the new museum, and that lectures should be given upon the principal contents of the museum, just in the same way as at the College of Surgeons, where they have perhaps the first osteological and anatomical collection in the world, and where Professor Flower is at the present moment engaged in giving lectures, which are illustrated by the contents of the museum.

6785. (*Professor Huxley.*) Is it not the case that the lectures which Professor Flower gives at the College of Surgeons are lectures of an extremely



advanced character ; that is to say, he takes advantage of his large knowledge and special study of that particular branch of comparative anatomy to expound the most advanced state of knowledge upon the subject on the basis of that museum?—That is certainly true to a great extent, but at the same time he goes into the most elementary facts, for I have seen him write down the commonest zoological terms, in order that the students, who attend his lectures in considerable numbers, may not miss them for want of a clear pronunciation or otherwise.

6786. That is quite true ; but unless the theory of the Professor is altered since the time I held it, it was always regarded as a position in which the most advanced truths of comparative anatomy should be taught, and not as apparatus for elementary instruction?—Certainly not merely as apparatus for elementary instruction.

6787. The same thing holds good with regard to the lectures at the *Jardin des Plantes* ; that is to say, the Professor, who is also the Curator in each case, there gives lectures which are supposed to bring the subject up to the level of the knowledge of the time?—Yes, I believe so.

6788. On the other hand, the sort of lectures you contemplate are those which would be useful for quite elementary teaching, are they not?—I have not formed a special idea of the sort of lectures in my mind, but I think that both sorts of lectures are useful, and both might be given. This is a matter not of primary importance, but a matter for arrangement subsequently.

6789. Do not you think that there would in many cases be a considerable difficulty in combining the functions of professor and curator in the same person?—I think there would be considerable difficulty, but I do not think it is positively necessary that the curator should be also the lecturer.

6790. To take your own special subject of ornithology, do not you think it one man's work to understand systematic ornithology?—I think it is more than one man's work.

6791. If the gentleman in charge of the ornithological collection in the new museum only had to discharge his duty with respect to that collection, he would have no time on his hands to devote to teaching?—Certainly not.

6792. If I understand you, you would not connect the teaching apparatus with the conserving apparatus?—Not necessarily, certainly.

6793. Supposing that the Government established a School of Science, or a College of Science, in the immediate vicinity of the Natural History collections, does not it occur to you that the teaching of science might be much better carried on there by the officers of that institution than by the officers of the museum?—I think certainly it might, supposing facilities were given for the removal of the necessary specimens for illustrating the lectures.

6794. You have yourself a very valuable collection of birds ; would you like to permit those specimens to be handed about by the students after the lectures for the purpose of examination, and what do you think would come of your collection in five years if they had an opportunity of so doing?—I think that of course it is not every specimen that ought to be handed about in that way.

6795. Do you not think that for the purposes of teaching, a comparatively simple collection of comparatively inexpensive objects which may be handled and can always be replaced is the thing that is wanted?—For elementary teaching, certainly.

6796. So that there really is no precise connexion between teaching and the elaborate and splendid collections which are gathered together in the National Museum?—Certainly no precise connexion. It would certainly not be the primary, but quite a secondary point for the museum authorities.

6797. You would not under any circumstances connect the teaching absolutely with the office of curator?—Certainly not. I think it would be very objectionable to do so.

6798. (*Chairman.*) What in your opinion is the first point to be considered as to the arrangement of the collections in the new museum?—I think that the most important thing is to divide them into two series : first of all, objects intended for public exhibition to be arranged in the public galleries which I have spoken of before ; and, secondly, objects intended for the examination of scientific students and the officers only. Those two portions may be treated in very different ways in the new museum. The objects for the public must of course be mounted in the best way possible, and must be illustrated in every way, and they would consist of a series of representative specimens of every class of Natural History from the highest to the lowest. Thus, for example, in the Mammal, I suppose you would exhibit the stuffed skin and the skeleton of both sexes, and the young ; and probably you would exhibit specimens of the internal organs if they presented anything of special interest, so as to get as complete a knowledge as possible of this one animal, which would serve as a representative of all its near allies of every sort. Then in the same way with a bird, you would exhibit the mounted skin, the skeleton, the egg, the nest, and everything that you could possibly get to make a complete picture of the life of that single animal, and that would serve as the representative of all its numerous allies of every description. I think that a series of mounted specimens exhibited in that way in a public gallery would give a much better idea of Natural History than the crowd of specimens that are now put into the cases so closely packed together that it is impossible to distinguish one from another. As regards the objects intended for a scientific examination, they should be treated in a very different way altogether. They should be packed together in cabinets and made as accessible for easy examination as possible. Except for persons who are engaged in this sort of work, it is impossible to understand in how very small a space a really workable collection of zoology may be packed together. Professor Huxley was alluding just now to the collection of birds which belongs to me. I have between 6,000 and 7,000 specimens all contained in a little room not 20 feet square. They are arranged in 10 or 12 cabinets, and so arranged that I can find any single specimen in a minute without the slightest difficulty. The National collection, I do not suppose, at the present moment, contains more than 30,000 birds of all sorts, and, therefore, it might be said that in four or five rooms of this kind you might stow away the whole of the collection of birds, and more than the whole of the collection ; in fact everything that is wanted for the working of the National collection.

6799. Having regard to the transference which is contemplated of the Natural History collection from the British Museum to South Kensington, and to any form of scientific re-arrangement which may be adopted for the purposes of study and for exhibition, have you thought of the crisis of administration which will perhaps arise, and the importance of having a Director of some considerable scientific attainments to carry out such a change?—Certainly the Director of the new National Museum ought to be the best man that can possibly be got for the post.

6800. Especially with a view to this transference and re-arrangement?—I think so particularly with a view to the re-arrangement of the objects in the new museum, but I think that the Government ought not to wait until the museum is actually built to appoint such Director ; it ought to be done at once, and the plans and the whole way in which the museum is to be built and arranged ought to be carried out under his direction. It would be very absurd to build a new building without consulting the person proposed to be named as the Director, and then turn him in and say, "Now, here is your building, you must make the best of it." The plans ought to be made under his special superintendence in my opinion.

6801. Might there not be very great risk of confusion unless such an appointment were made at a very early period of a man of very high qualifications?

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14 March 1871.



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—I think there would be very great risk, and that the appointment ought to be made before the plans are finally settled upon, and that the plans ought not to be finally settled upon, or anything like finally settled upon, without consulting the new Director; in fact the plans ought to be the plans of the new Director.

6802. Do you think that the separate series of mounted specimens, osteological specimens, and spirit specimens now in the British Museum ought to be amalgamated?—I think so, certainly. I may say that I frequently have to go to the British Museum to make examinations, particularly of mammals and birds. Supposing that I want to examine a mammal, first of all I go up to the gallery of mammals, and examine the specimens there. Then I have to go to a cellar in the bottom storey, and examine the specimens of the same animal kept in what is called "in the skin." Then I have to go into another cellar, and examine the bones of the same animal, which are kept as a separate collection; and then I may have to go into a third cellar to examine specimens kept in spirits of the same animal: so that in many cases there may be specimens of the same species distributed over the four quarters of the building. That, of course, is most objectionable. It causes a great waste of time, and it would be much simpler to have all the collections amalgamated into one series.

6803. (*Professor Huxley.*) Is it not the case that at present there is no Comparative Anatomy Collection, properly so called, apart from osteology in the British Museum?—There is a large Osteological Collection.

6804. But there is no Comparative Anatomy Collection there in the sense in which you would speak of the soft parts?—None whatever.

6805. You are aware that the formation of a collection of that kind would be a very serious undertaking?—I am quite aware of it.

6806. Has it ever occurred to you to consider how far it might be desirable for the Government to attempt to amalgamate the present British Museum Collection with the very fine collection of dissected soft parts which is contained in the Hunterian Museum, and which is to a certain extent, though to a very small extent, Government property?—Yes, I have thought very much upon that subject. I am well aware that the maintenance of the Hunterian Collection in an efficient state has become a great burden to the Royal College of Surgeons. As the State has a certain claim, to say the least, over that collection, I think it would be advisable, if possible, to make arrangements that it should be removed also to the Museum of Natural History. There can be no doubt that the junction of these two collections, particularly as regards osteology, would make the national collection the finest in the world, even if it is not so now.

6807. I am quite safe, am I not, in saying that such a collection of soft parts as exists in the Hunterian Museum could not possibly be formed in half a century, whatever money or labour you spent upon it?—I should think it would be quite impossible, because there are many specimens that only come at rare intervals into the country, and, therefore, could not be obtained at any moment.

6808. And there is some danger, is there not, that unless the Government take the matter in hand, the College may be unable to bear the burden of keeping up that very fine collection?—I have had several conversations with various members of the College and the officials upon this subject, and I am afraid that there is some chance of their being unable to keep up the collection; in fact, I know that they have been very much straitened within the last few years.

6809. (*Dr. Sharpey.*) Are you aware that the obligation felt by the College of Surgeons to maintain that collection stands somewhat in the way of improved arrangements that were contemplated for the examination of medical candidates in this country; that is to say, that in consequence of the

money which is required to be set aside for maintaining the Hunterian Collection, considerable difficulty is occasioned in a union of the licensing bodies in London to grant a common qualification for medical and surgical practice?—I was not specially aware of that point.

6810. Were the College of Surgeons relieved of that obligation, those arrangements would be facilitated, would they not?—Yes; but I was not specially aware of the fact.

6811. (*Professor Huxley.*) Supposing that the collection of dissected soft parts in the College of Surgeons' Museum were added to the National collection, would you propose to place those dissected soft parts alongside of those specimens which are exposed for public observation, or would you see any advantage in that course?—I think that there must be some discretion used in adopting any course of that sort. I see no objection to exhibiting specimens of any very remarkable peculiarity of structure of the internal organs. I think that the digestive system might be illustrated in the case of the principal animals and birds, and so on, without any difficulty.

6812. I agree with you, that properly displayed dissected specimens of characteristic organs would be very important indeed, but it is quite another matter when you come to speak of interpolating a whole set of preparations in their place among the rest. I imagine you would think that inexpedient?—It would be quite inexpedient to think of interpolating the whole series, but it would be otherwise to make a judicious selection of such specimens as are required to illustrate the internal structures.

6813. I presume the same argument would apply to the spirit specimens, and the osteological specimens. I apprehend that part of your object would be to interpolate a sufficient number of such?—Yes, a few of them; and the rest would be put into store along with the skins and skeletons.

6814. (*Chairman.*) What is your opinion as to the maintenance of a separate Palæontological Department?—I am certainly of opinion that Professor Flower, who has put forward his views on that subject on more than one occasion, is correct, and that it would be better for the general advancement of the sciences of zoology and botany in this country that the Palæontological Department should be merged into the General Department, and that there should be no separate department of palæontology, but that a series of the remains of extinct organisms should be interpolated in their natural position, as nearly as we can judge of it, along with the specimens of the living creation.

6815. (*Professor Huxley.*) I presume that that recommendation also would be with the sort of caution previously indicated about osteological specimens and spirit specimens. You would not intend to interpolate in the series of reptiles, for example, all the specimens of Ichthyosauri which the British Museum might happen to have?—Certainly not. I should put in two or three good typical specimens of the Ichthyosauri; the rest I should pack in the most convenient way in the students' room, to be examined by the students.

6816. In like manner, with regard to the collection of shells, you would display every fossil type?—Yes, every fossil type in public galleries. I do not think it would be at all necessary that the Ichthyosauri should be put away in the same drawers with crocodiles, or whatever their nearest living allies may be. But there should be also students' and store-rooms for the fossil reptiles, only they ought to be in immediate proximity to the rooms containing the existing reptiles, in order, as far as possible, to amalgamate the study of the recent and the extinct remains.

6817. From a curator's point of view, and not a public point of view, there is a certain reason for having a palæontological collection; I do not mean to say under a separate Government or administration, but in a distinct part from the recent specimens, and that is this, that you cannot pack away Ichthyosauri



40 feet long in drawers; you must have them stuck up against a wall?—No more you can the elephants.

6818. You can pack away an elephant in drawers because you can take it to pieces, but you cannot by any means, if you have a great slab 30 feet long, with Plesiosaurs in it, take it to pieces; that is speaking from the curator's point of view, but from the public point of view, with the very great attraction which is felt upon the part of the public to see those great monsters displayed to view, it would be a great deprivation to the public if they could not look at the great Plesiosaurs upon the slabs, as they are now seen in the museum?—Certainly there ought to be a sufficient series of them in the public gallery; no doubt about it.

6819. But if you attempted to interpolate them among the recent things they would take up such an enormous space that I do not know what would become of your collection. That is the practical difficulty; and do you not think that some weight is to be attached to those considerations for having a gallery where those great things might be conveniently displayed?—I think there could be no objection to having additional galleries to display these particular points. They are things that you cannot make come in in the general series, but the point which I urge is, that there should be a typical or representative series of animals set forth in the public gallery, beginning from the highest and going down to the lowest, in order that the public might pass through the public gallery and get some idea of the general extent and modifications of the whole creation of animals, from the highest to the lowest.

6820. You would have every extinct type put in its place?—Yes, every extinct type, and every recent type as nearly as possible.

6821. But that does not imply that you should not have a separate Palæontological Gallery for the reasons I have indicated?—No, it does not necessarily imply that. But there can be no doubt that Palæontology has suffered greatly hitherto from its being considered quite a distinct science from Zoology, whereas Palæontology is merely the study of extinct animals, and it is impossible that we can study them without being acquainted with the structure of recent animals. Of course our knowledge of extinct animals must be mainly derived from the study of existing organisms. It has been in my opinion a great misfortune both for Zoology and Palæontology that the two subjects have hitherto been considered distinct, they being in fact one.

6822. But let me suggest that Palæontology has a double sense, and it is very important not to forget that in the first place Palæontology looks at fossil forms simply as modifications of the general type of structure; but then there is another sense in which Palæontology has to deal with fossils, and that is as assemblages of living forms in time, and in that sense I think it exceedingly desirable that there should be a Palæontological Collection by itself, a collection, that is to say, in which all the Silurian remains shall, if possible, be together, and all the Jurassic shall be together, and so on, so that quite independently of the zoological question there is very great need for a separate Palæontological Collection?—I quite agree to all that. I think there ought to be also a public gallery specially arranged to exhibit the fauna of each epoch of the world's age so far as we are acquainted with them. I would have a Carboniferous Gallery, a Jurassic Gallery, and so on, in addition to a series of purely zoological galleries.

6823. On the whole, taking the Curator's point of view, and the public point of view, there is some ground for a Palæontological Gallery?—Yes, there are good grounds for a Palæontological Gallery.

6824. (*Chairman.*) Have you any observations to make as to the sufficiency of the scientific staff of the present Natural History Department in the British Museum?—I think it is very inadequate at the present moment. The assistants and curators are much too few in number, and the work is very inefficiently performed in consequence. The collections are not

completely arranged, and the objects are not named and classified. I should mention particularly the Entomological Department as being one in which the curators are very insufficient. There are far too few at present engaged on Entomology in the British Museum.

6825. (*Professor Huxley.*) Would you explain to the Commission what you think would be an efficient organisation of the officers of the museum?—I should suppose that the museum would be divided into so many departments, very much in the same fashion as it is now, that there would be a chief appointed for each of those departments, and that he would be allowed an adequate number of assistants under him.

6826. Would you make one person Keeper of the whole of the zoology as he is at present?—I should say not. I think that would not be advisable, certainly.

6827. It would be advisable, at any rate, to make a division, would it not?—Yes, at least into vertebrates and invertebrates. You might appoint a principal of the Vertebrate Department and of the Invertebrate Department, and give him so many assistants under him; and then, of course, there would be a distinct botanist, supposing it is considered desirable to keep botany in the National museum at all, and so on, and a distinct keeper for mineralogy, of course.

6828. And a keeper of the fossils from a distributional point of view?—I think that is a question open to some discussion. That is a doubtful point, upon which I would not express any decided opinion until it came forward in a practical way.

6829. (*Chairman.*) Do you think the yearly sum allowed for zoological acquisitions sufficient?—No; I think it is at present not sufficient. I believe the sum allotted is never more than 1,000*l.* for zoological acquisitions of all sorts. I believe that although a copy of every book printed in the United Kingdom is sent to the British Museum, still they spend 10,000*l.* every year in buying books, and I do not think that is quite a fair proportion. It is well known that the Zoological Department in the British Museum is always short of money; and always in debt. I have frequently been told by dealers in zoological specimens that they do not care to sell to the Zoological Department of the British Museum, because they know that they will not get paid for several years. I believe that the whole sum allotted to the department is always spent before the money is actually received by a parliamentary vote, and I think that is a conclusive proof that the sum allowed is not sufficient.

6830. Is the accommodation provided for the work of the scientific staff sufficient?—That is also very inadequate in the present building; only two or three of the principal officers are provided with studies for themselves. Many of the assistants are congregated together in a large room where there is no possibility of carrying on quiet scientific work, and this room is situated in a cellar underground; it is very badly lighted, and, moreover, one of the regulations of the Museum is that no lights of any sort are allowed. During the whole of the winter months, therefore, these gentlemen often have to sit there and do nothing at all. It is impossible for them to work, because they have no light. They are not allowed any gas or light of any sort, so that they have simply to sit there in idleness. I have been there in December on a foggy day, and seen them sitting there doing nothing.

6831. Is there any accommodation provided for the students of the Zoological Department?—No, there is no accommodation at the present moment. If they happen to be friends with any Curator they can go into his private room and get a corner to work in, but the accommodation is miserable in the extreme.

6832. What arrangements are at present made for the distribution of duplicates?—I believe at the present moment there is no sort of arrangement made for the distribution of duplicates. The doctrine of the Trustees or of the executive of the British Museum is that any specimen that is brought into the Museum cannot go out again, not even for the purpose of being figured or shown at a scientific meeting of any society,

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or for any other purpose whatever. That is what is carried out in practice, and I believe it is literally the rule of the Museum. I may observe that I have had frequent opportunities of putting this to the proof, because a very large number of specimens in the British Museum are derived from the Zoological Society's Gardens. These being the subjects of communications at the Zoological Society's meetings, I have frequently wished to have the specimens described placed upon the table at the meetings when the communications are read, and if those specimens have been already put in the Museum and registered as belonging to the Museum, I have always been told that it is impossible that they can be brought out for exhibition. Sometimes specimens are kept in the Museum for some time before they are finally registered, and in such cases, and by special application to the head of the department, I have obtained leave as an extraordinary favour for those specimens to be brought and exhibited at scientific meetings, but as a general rule I am told it is impossible that any specimen once registered and put into the Museum can be taken out again. I may mention one case of an animal which was given by myself to the British Museum. I was anxious to have it out for the purpose of being properly figured, for it was impossible that the artist who was employed upon it could figure it in the cellar where he was put to work; it was so dark. My friend, Dr. Peters, the Director of the Royal Museum at Berlin, was in London and undertook to describe this animal, and although I asked to have it out, having given it myself to the Museum, I was told it was quite impossible, and the specimen was ultimately drawn in the cellar in the dark.

6833. (*Professor Stokes.*) Are specimens which are ascertained to be duplicates registered as belonging to the Museum?—All specimens as they are received are registered in a register called the Register of Zoological Accessions, and after that they are supposed to be the property of the Trustees of the Museum, and are not removable.

6834. But even supposing it were ascertained that the specimen was a duplicate of one already in the Museum, and was not required for exhibition, would it then be registered?—Yes; all specimens acquired are registered.

6835. Then it would be considered that they could not leave the Museum?—That is always the doctrine that I have heard stated. Whether it is really one of the Rules of the Trustees I am not quite so sure.

6836. (*Professor Huxley.*) Have you ever applied to the Museum to exchange a duplicate?—Yes, I have applied.

6837. With what result?—I have given a great many specimens to the Museum, and I once got one specimen of a bird in exchange, and that I have at the present moment. At the same time I should wish to say that in my opinion there is a great deal too much said about duplicates in the British Museum. There is not really the quantity of duplicates in the British Museum that there is usually supposed to be. In order to examine any species of animal satisfactorily it is necessary not only to have one specimen, but to have four or

five or more specimens in many cases, for it is impossible to ascertain the limit of variation of any particular species by examining one specimen only; therefore, a great National Museum ought to have a series of specimens of each species. Moreover, it ought to have specimens from different countries, because we all know that the laws of distribution of animal life cannot be worked out without a series of specimens from every locality in which the species is known to occur. Therefore, I do not myself believe that there is that large number of duplicates in the British Museum that could be so readily parted with as some people imagine.

6838. (*Dr. Sharpey.*) Have you considered whether it would be advisable, or, if advisable, practicable to apply any part of the revenue of the British Museum to the publication of figures of rare and important objects which are added to the Museum from time to time, so that naturalists might make use of them; especially as regards Palæontography?—That would certainly be a very desirable object. It is known to everybody that the museum of the *Jardin des Plantes* of Paris has for years issued a series of papers which are called by various names: the *Annales de Musée*, the *Archives de Musée*, and so on. The Professors are supposed, when they make any important discovery, to contribute notes of it to this journal which is edited by one of themselves, and that has been the means of bringing many of the most important zoological and botanical discoveries before the world. At the same time I may say that we have in London a great many scientific societies which are always ready and willing to publish those papers, and, therefore, it is not so absolutely necessary to have a periodical of that sort attached to our National Museum as it is in the case of Paris, where the Museum is looked upon as the centre of everything, and there are not that number of separate scientific publishing societies that there are in London.

6839. (*Professor Huxley.*) It is true that in some cases the Government authorities take advantage of the publications of the societies, is it not?—I should say that the greater part of the papers written now by the officers of the British Museum are published by the scientific societies; therefore the scientific societies are *pro tanto* aiding the Government in a very liberal way.

6840. And not only so, but even in a more definite way than that; the illustrations of the scientific catalogues are occasionally taken by permission from the publications of the Zoological Society?—Yes, a large number of woodcuts that have been prepared to illustrate papers in our "Proceedings" have afterwards been allowed to be used by the Trustees of the British Museum to illustrate their Catalogues of different branches.

6841. It has been so much contribution by those Societies to the work of the Government?—Yes.

6842. (*Dr. Sharpey.*) Do not you think it might have been the converse with advantage?—I think certainly that we ought to get for science all out of the Government that it is possible to do.

6843. (*Chairman.*) Is there any other point which you would desire to communicate to the Commission?—No, I am not aware of any.

The witness withdrew.

Professor  
Flower, F.R.S.

Professor FLOWER, F.R.S., examined.

6844. (*Chairman.*) I believe you are Hunterian Professor of Comparative Anatomy and Physiology, and Conservator of the Museum of the Royal College of Surgeons of England?—Yes.

6845. Will you be good enough to give the Commission your opinion regarding the best mode of arranging and exhibiting a zoological museum for the instruction of the public?—In the first place, I think that it is an essential principle that it should be open all day long, and every day if possible; that it should be closed only for such short periods as may be absolutely necessary for sweeping and cleaning. Then I think that the exhibited specimens should

not be too numerous; they should be very carefully selected as illustrations, and they should all be extremely good of their kind—not the sort of specimens generally seen in nearly all the zoological museums that I know at present, both in this country and on the continent—and every specimen should be extremely well preserved. For instance, far better pains should be taken in stuffing birds and in mounting specimens than is taken at present. Each zoological group should be kept perfectly distinct from all others. Our existing museums are generally too much crowded. For instance, at the British Museum you may see a set of small animals like the arma-



dilloes filling up the interstices between the legs of ruminants and so forth, producing a great deal of confusion in the mind of visitors to the museum, who wonder what those animals have to do with each other. At any sacrifice of space I should keep each group perfectly distinct from the other. Each group should be illustrated by its most prominent forms, both recent and extinct, which I should prefer to keep together. There should be legible tickets attached to all the specimens stating their name, and, as in the Kew Museum, giving their geographical distribution, and any other useful information about the animals that may be required for the general public. I think also that it would be a great advantage if the fronts of the glazed cases that are turned towards the public could be perfectly closed, so that no dust could get into them from this side, and so that there should be no interference with the constant examination of the specimens by visitors at all times. If the cases were hermetically closed towards the public there would be no objection whatever to having gas, to light the museum in the evening.

6846. With a view to zoological research, have you any suggestions to make as to the arrangements of the museum?—As all zoologists who wish to advance the knowledge of their subject require a very much larger number of specimens for examination than those which are required for inspection by the general public, the great bulk of the collections should be kept arranged in drawers with every facility for access and reference; and it would be a great advantage, almost indispensable in fact, that the rooms in which the bulk of the collection is kept in this way, arranged much as books in a library, should be contiguous to the galleries where the exhibited specimens are kept. I think the best plan (one which has been frequently advocated already) is, that the backs of the cases containing any particular group of animals should open into a room where the large number of specimens of the same group are kept for zoological research, so that if an exhibited specimen is required to be compared with the other specimens that are kept in the drawers, it can at once be removed from the case, examined, compared, and put back again in its place, which could be done in so short a time that its absence would scarcely be noticed by visitors passing by in the gallery. Of course in a new National Museum of Natural History there should be provision for very much space for specimens arranged in this way, far more than is the case in any zoological museum at present existing, and there should be much greater facilities for examining them than there are at present.

6847. Will you give the Commission your opinion as to the best method of dividing and organizing the different departments of the Museum?—I think myself that the best method would be a zoological arrangement. There would be certain departments, the head officer of each taking charge of one of the great groups into which zoologists generally divide the animal kingdom, and having a staff of assistants under him who should each, under his general direction, take charge of a subordinate group of those great divisions; and I also think that it would be a great advantage if the palæontological collections of any particular group of animals were placed under the charge of the same person who takes care of the recent specimens, instead of having a distinct palæontological department, as is the case at present.

6848. (*Professor Huxley*.) Are there not two senses of the word "palæontology," one of them in which the term has reference to extinct animals, as animals, simply as forms of animal life, and the other in which the term has reference to the distribution of animal life in time. I entirely agree with what you say about the advisableness of putting in amongst the recent specimens the representatives of all the extinct types of form; but would it not be desirable at the same time to keep the palæontological collection by itself in relation to stratigraphy; that is to say, to have, as in the Museum in Jermyn Street, the collections of fossils arranged in the order of their occurrence

in time, so that their successive forms could be inspected and examined?—I think it would be very desirable to have such a collection if there were room, and the means for doing it, just as there might also be a collection illustrating the geographical distribution of animals, but it would be, I consider, subordinate to the main collection. I think that the large bulk of the palæontological specimens showing the minute and transitional variations in species should be left in the zoological galleries, and if there were in addition a special stratigraphical or geological collection, it should only contain examples of the more characteristic and typical species illustrative of each stratum.

6849. You would have no objection to a separate stratigraphical collection?—None whatever. I think it would be a very useful and instructive supplement to the main collection.

6850. From a practical point of view, do not you think there is a little to be said in favour of keeping the great fossils by themselves. You are quite well acquainted with the numerous and very remarkable specimens of Ichthyosauri and Plesiosauri in the British Museum. Some of those are different species, and some are not, but if you were to interpolate all those specimens of Ichthyosauri and Plesiosauri with the collection of recent reptiles they would take up a considerable quantity of room; you cannot pack away a great slab containing the skeleton of an Ichthyosaurus in the same way as you can take to pieces a duplicate reptile-skeleton and put it away. On the other hand, considering the great interest the public take in seeing those great extinct animals, do you think there would be any objection to having such specimens as could be spared from the general collection inside placed along with your other fossils, supposing that a certain series of stratigraphical fossils were made?—The arrangement of specimens too large to fall in their ordinary place in a natural series is always one of the greatest difficulties which curators of museums have to contend with. I cannot, however, see that these fossils will occupy more space or be less appreciated by the public if placed in a gallery containing specimens of recent reptiles, than they would in one devoted to a stratigraphical collection. But this is a subject which will require much care and thought on the part of those persons who have charge of the collections.

6851. Still you have no objection to the separate stratigraphical collection?—Certainly not. What I should principally object to is, to have, as at present at the British Museum, a collection of recent animals arranged zoologically, and another collection of extinct animals also arranged zoologically, the arrangement adopted in either case frequently not coinciding with that of the other.

6852. (*Chairman*.) What amount of anatomical illustration would you desire to introduce into the zoological museum?—I think it should be as full as it possibly can be. Unfortunately the subject of anatomy has hitherto been too much divorced from zoology generally. I should not be content with a Museum of Natural History that had merely skins, as is the case in some museums, or even merely skeletons; but I would have every other part of an animal exhibited if possible by well prepared specimens.

6853. How far does the Museum of the Royal College of Surgeons carry out the object of providing illustrations of comparative anatomy on a scale suitable for a National collection?—The museum of the College of Surgeons is an extremely good collection simply as an introduction to anatomy and physiology, but for zoological purposes, on its present scale or upon any scale upon which it is ever likely, with the present or probable means of the college, to be carried on, it must be quite insufficient for zoologists, because illustrations cannot be provided of all the details that are required by them; but, as an introductory collection, arranged, as it is, on what is called the physiological plan, that is to say, all the more important variations of any particular organ being shown, it is an extremely valuable collection. And I think that

*Professor  
Flower, F.R.S.*  
14 March 1871.



Professor  
Florey, F.R.S.  
14 March 1871.

it would be unnecessary for the British Museum Natural History collection to attempt to do this, but it should rather aim at a complete anatomical collection arranged zoologically, every particular genus of animals having its brain, its heart, and every part of it shown, and kept near the skin and near the skeleton. The two collections then would supplement each other, and not interfere in any way whatever. The student who wants to gain a general insight into comparative anatomy will always come to the College of Surgeons first. He wishes, for instance, to learn something about the brains of animals, and he will there find side by side the brains of members of each of the principal great groups; he will compare one with another, and get such an amount of knowledge of their leading modifications as will content a great many people. But if he wishes to go more deeply into the subject he will go to the new museum; he will take up the brain of one particular group of animals, and he should be able to find them all together, apart from those of any other group, and there he should find the means of working out all the details. So that, I think, there would be ample room for both collections, and a real function for both; and they need not interfere in any way with each other if they are both carried out upon some such plan. I think they would work very well together, and exchanges might be made if the establishments were both in harmony, and both had a definite object.

6854. Would you keep the Museum of the Royal College of Surgeons separate, or would you unite it with the proposed museum of Natural History at South Kensington?—I think it would be a very great disadvantage to move it to Kensington, as the local position of the Museum of the College of Surgeons is very much more convenient to medical students, who, being necessarily engaged for the greater part of the day at the different medical schools and hospitals, could not possibly give up their time to go so far as Kensington to investigate these subjects.

6855. If you did not remove it, would you place it under the same superintendence with that of the zoological collection at South Kensington?—I do not see that there would be any great objection to some arrangement of that kind being come to, if it should appear that the College of Surgeons are not able to keep it up. The College has hitherto had no difficulty in maintaining it in an efficient condition, but the whole question of medical legislation is now under discussion, and there is some uncertainty as to what the position of the College of Surgeons will be in future, and whether the Museum will be kept up by the College as it has hitherto been.

6856. What arrangements would you make as to the form of instruction in zoology, by means of lectures or demonstrations by the officers of the Natural History Department?—I think it would be on the whole an advantage to zoological science as well as to the Curators of the different departments if it were part of their duty to give some sort of instruction. This might be done either by the head of each department or one of his assistants, that he might appoint. I know it is a question upon which there is a difference of opinion, but if the amount of labour required by giving lectures were not too great, and if it were subordinate to the main duty of taking care of the museum, it would give a man very often more interest in the collection under his charge, and I think it would rather check a tendency that curators frequently have to consider that the collection is almost entirely for their own benefit, rather than for the benefit of other people, if they had to give short courses of lectures specially illustrating some portion of the museum under their charge.

6857. (*Professor Huxley*.) You would not, I presume, have those lectures elementary lectures, but advanced lectures on the particular department with which they were concerned?—Advanced lectures. I should allow (under some general supervision, of course, of the Director of the whole museum) the lecturer to select some subject that he happens to be working

at in his duty of arranging or cataloguing the collection under his care, and to give a short course of lectures upon that particular subject, illustrated fully by the specimens in the museum.

6858. In fact the Curator would bring his special knowledge to bear, and give the advantage of that special knowledge to the public in that way?—That would be the object.

6859. Apparently it does not occur to you that the museum would be the proper place for giving elementary instruction?—I do not see that there would be any advantage in that. At all events the officers of the Museum would not be the right persons to give it, as their duties should be principally and mainly the care of the particular collection under their charge.

6860. I am not quite sure that I fully apprehended whether you have any objection, supposing the thing were otherwise practicable, to the merging of the collection of the Royal College of Surgeons, so far as its anatomy and zoology is concerned, in that of the new Natural History Museum?—I think it would be a great misfortune to take away the Museum from the College of Surgeons, locally speaking, but I am not quite sure that it might not be an advantage to combine the direction of the two in some way or other.

6861. The misfortune, I presume, would arise from the fact that the medical students who now consult it would not be able to consult it under those new circumstances?—I am afraid they would not.

6862. Do not you think that when the new scheme of medical education is carried out, the medical students will have a great deal less to do with comparative anatomy than they have now?—There are now, and I hope always will be, a certain number of medical students who take an interest in comparative anatomy; and besides those studying the medical profession there are many other students who come a great deal to the College Museum.

6863. Then that difficulty would not apply to them?—Not so much, as they are not fixed to a certain locality by the position of the Hospitals as are the medical students.

6864. I presume that you have no doubt as to the necessity in any complete Natural History Museum of such a collection, either affiliated or existing in the museum?—No. I think that the Museum of the College of Surgeons, or such a museum, is a necessary introduction to the general museum of comparative anatomy and zoology. It is of no use to attempt to investigate the structure of any particular group of animals unless some general knowledge has been acquired of all the different organs of which the animal body is composed, which could not be obtained in a zoological museum unless there were such a collection; and I think it would not be worth while, having already the Museum of the College of Surgeons, which has existed so long and upon which so much money has been spent and so much care been bestowed, to commence to form in the same town an exactly similar collection somewhere else. It would be throwing money away, because the cost of that collection has been very great.

6865. Do you think you could make such a collection within 50 years?—It is entirely a question of money.

6866. Could you always get specimens when you wanted them?—I ought to say that both time and money would be required, but chiefly the latter, since the facilities for getting specimens are much greater now than they used to be in former times.

6867. Supposing the College of Surgeons' Museum could be kept in its present general arrangements, and transferred, so to speak, bodily, and kept in a place by itself wherever the New Natural History Museum might be, would you see any objection to that?—That would depend very much upon where that museum might be situated. I presume you are only speaking of the collection of comparative anatomy; for the Museum of the College of Surgeons is a compound museum, containing several distinct collections. A large part is pathological, which the college would not be likely to part with. The answer to the question



depends mainly upon whether the College of Surgeons is able and willing in future to keep up the Museum efficiently or not. If it should be unable to do so it would be better to transfer it than to let it become inefficient, but I cannot help thinking that its bodily transference would be felt as a loss by a very large number of people.

6868. But only to the student class, because other persons consulting it, foreigners, for example, could get to South Kensington just as well?—Foreigners could quite as well. The loss would be chiefly to the student class, and to medical men who take an interest in the collection.

6869. (*Dr. Sharpey.*) Could you tell the Commission approximately what the maintenance of the Museum of the College of Surgeons costs the College?—Merely approximately, because the accounts are complicated with those of other departments. I should say about 2,500*l.* a year.

6870. Whence is that money derived?—It is derived from the revenues of the College, which are mainly obtained from the fees paid by the medical students on passing their examinations, and partly also from property which the College possesses.

6871. So that a considerable part of the fees paid for the diploma of the College by the students who obtain it goes to maintain the museum?—It is hardly a considerable proportion of all that is paid; something less than one-fifth of what each pays may go to the maintenance of the museum.

6872. Are you aware whether the necessity of their

The witness withdrew.

Adjourned to Monday next at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Monday, 20th March 1871.

PRESENT :

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, BART., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

SIR JOHN LUBBOCK, BART., M.P., F.R.S.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D., Sec. R.S.

WILLIAM GRYLLS ADAMS, Esq., M.A., examined.

6876. (*Chairman.*) I believe you are Professor of Natural Philosophy at King's College, London?—Yes.

6877. How long have you held that office?—Since Easter, 1865.

6878. The system of teaching at King's College proceeds by lectures, class teaching, and practical work in experimental subjects?—Yes.

6879. What is the condition of the knowledge of students on entering?—The standard is very low generally. On entering the Applied Science Department, with which I am more particularly connected, the students have a very limited knowledge of mathematics, and generally their knowledge of natural philosophy is very slight indeed.

6880. What would you propose as to any entrance examination, looking at it from various points of view?—An entrance examination would be very valuable, it would make the work of the College of a higher kind than it is at present, and it would enable us to do more valuable work, because it would give us better material to work upon. It would no doubt diminish the number of students entering, at least at present, because of the difficulties in connexion with engineering out of doors. I have no doubt that it would diminish the number considerably, because there is not a sufficient demand for engineering education.

6881. But if the College had independent resources of any kind, you would conceive that it would be a great advantage to have a matriculation examination?—It would be a very great advantage.

6882. The staff would be more usefully employed,

setting aside a portion of the fees for this purpose has rather stood in the way of arrangements between the different licensing bodies in London for a common examination?—That I cannot say, as I am not fully acquainted with what has taken place with reference to the arrangements that are now being discussed.

6873. That sum has to be provided for, has it not, out of the fees of the students, and from the fund from which the expenses of conducting the examinations may be paid?—Yes, that has probably created some difficulty. The Council of the College of Surgeons of course would not be willing to make any arrangement that would deprive them of the means of keeping up the museum, unless they saw any other means by which it might be maintained.

6874. Supposing it were taken in hand by the nation, would that be an advantage or not?—I should myself think that the charge of maintaining the College of Surgeons' Museum might very fairly be borne by the nation, considering that the benefits of the Museum are as much for the nation as for the particular body of the College of Surgeons. The nation already has given something, although not to the annual maintenance of the museum, yet in the way of purchasing the original Hunterian Collection, and various grants towards buildings, amounting altogether to 57,500*l.*

6875. (*Chairman.*) Is there any point arising out of your examination, or otherwise, that you would like to communicate to the Commission?—No, nothing further occurs to me at present.

*Professor  
Flower, F.R.S.*

14 March 1871.

*W. G. Adams,  
Esq., M.A.*

20 March 1871.

it would be devoted to a higher kind of scientific education, and it would have more time for original investigation?—Yes; at present the staff is not sufficiently numerous, and is too busily engaged to allow of time for original investigation.

6883. What is the amount of time now occupied by the professors in the work of instruction?—In mathematics the hours for lectures are between 20 minutes past 10 and 1 o'clock every day, except Saturday. For mechanics and physics the hours for lectures are the same on four days in the week, and in addition to that, in the Applied Science Department, the third year's students have practical work in physics. The Demonstrator in Physics also gives three lectures weekly to classes in the school, and at other times up to 4 o'clock every day the Professor and Demonstrator are busily engaged in teaching occasional students in the physical laboratory. The Professor of Chemistry gives two lectures weekly to Applied Science Students, and four lectures weekly to Medical Students, and with the help of two Demonstrators instructs the Applied Science and Medical Students in practical chemistry, and teaches occasional students in the Chemical Laboratory. Occasional students are those who attend special classes in the College, and pay a separate fee for each class. The professors and lecturers also give instruction in the evening classes.

6884. Different lines of study, I presume, are pursued by different classes of students?—We have definite courses of study in the College, for those who are termed matriculated students. The General Literature and Science Department is divided into two divisions. In the classical division, classics,



W. G. Adams,  
Esq., M.A.

20 March 1871.

mathematics, French, German, and English are the principal subjects. Then there is the modern division of the General Literature and Science Department, in which division the subjects taught are English, Latin, mathematics, French, German, chemistry, physics, and drawing.

6886. For what class of students is the Applied Science Department chiefly intended?—It is chiefly for engineering students, but not exclusively. The course of study is suited for engineering students, and this table will show the different hours devoted to the different subjects in that department. Pure mathematics, five hours a week for the students in each year of the three years. Mechanics from three to four hours a week on the average. Physics, chemistry, and other subjects occupy the number of hours given in the table. (*The witness delivered in the following paper.*)

At King's College the course is divided into three sessions, with three terms in each session, affording about 11 weeks' actual tuition in each term, and includes the following subjects:—

TIME TABLE.

	1st Session. Hours Weekly.	2nd Session. Hours Weekly.	3rd Session. Hours Weekly.
Pure mathematics	5	5	5
Natural philosophy	2	4	2½
Mechanics (theoretical and practical)	2	1	1
Physics	0	0	1½
Physical laboratory	3	4	4
Mechanical workshop	3	2	0
Chemistry	0	0	2
Practical chemistry	0	0	1
Civil engineering and architecture	2	2	0
Machinery and mechanical engineering	7	6½	6½
Mechanical drawing	2	2	2
Surveying and levelling	2 in two terms.	2 in two terms.	0
Mineralogy	1 in one term.	3 in one term.	3 in one term.
Geology and mining	0	0	0
Photography	0	0	0
Total (about)	28	31	30
Fees for this course	£42	£42	£45

Library and matriculation fees, &c., 5l. 17s. 6d., to be paid on entrance.

The professors of civil engineering and mechanical engineering require, at regular intervals, essays on some practical subjects from third year students.

In addition to one lecture in each week during the first two sessions the professor of mechanical engineering takes the students in his classes to visit manufactories in the neighbourhood of London. The average time is thus two hours a week for each session.

In addition to, or instead of, certain parts of this, the regular course, the second and third year's students can, and frequently do, attend and receive instruction in the chemical or the physical laboratories, which are open to them and to others (occasional students) for several hours daily, on payment of an extra fee of from 4l. 4s. to 8l. 8s. a term, or 10l. 10s. to 21l. for three terms, and in which there is always a professor or demonstrator to give instruction and assistance. The engineering drawing class is also open for three hours daily (except on Saturday), and the mechanical workshop (in which the first year's students do wood work, and the second and third year's students do metal work) is open for six hours daily (except on Saturday, when it closes at 1 p.m.), and in each case there is always some one to give instruction and assistance.

For many years past, notwithstanding the depressed state of engineering, the number of students at King's College, attending the above course, has ranged from 75 to 95 in each year.

6886. With respect to the physical laboratory, is there anything that you would desire to state to the Commission as to its foundation and extent?—It was founded about three years ago. A representation was made to the Council of the College by myself, supported by the late Dr. Miller, that there should be lectures on physics and a physical laboratory in connexion with the College. Considering the means at their command, the Council responded liberally, and

made very satisfactory arrangements for the teaching and practical study of physics. Adjoining the museum, which is 66 feet by 30 feet, with cases all round the walls full of physical apparatus, two other rooms were set apart, one 30 feet by 18, and another 30 feet by 40, the first for a laboratory for the Professor to prepare his experiments, and for the more delicate experiments made by the students, and the other for the general experiments to be made by the students. In addition to these, another room was built for a battery room and storeroom, and a lecture room capable of containing 80 students was set apart for experimental physics.

6887. Will you describe the work of the physical laboratory, and the results of the practical teaching?—The physical laboratory is adapted to the wants of those students who wish to acquire a thorough practical knowledge of pneumatics, heat, light, electricity, and magnetism. The course of practical work for any student depends on his previous knowledge; and he may pursue any one subject in detail, so as to obtain a thorough knowledge of its principles and practice. Students are taught to use the barometer, thermometer, cathetometer, and hygrometers; to determine the specific gravities of solids and liquids; and the relative densities of gases and vapours under varying pressures and temperatures; to measure the amount of expansion of solids and liquids, and their specific and latent heats; to measure melting and boiling points; to measure relative powers of conduction of bodies for heat and for electricity; to measure the focal lengths of mirrors and lenses, the indices of refraction of various transparent substances, their powers of dispersion, and the relative distances of the fixed lines of the solar spectrum. They study the principles of the polarization of light, and the magnetic and electrical properties of bodies, the different methods of developing electricity; and learn to determine the electro-motive force and resistance of batteries, the strength of currents, the resistance of telegraph-wires in absolute measurement; and are taught the testing of cables, and the principles of telegraphy. The work of the physical laboratory I think is very important, because the effect of it has been to give students a thorough interest in physics, who before did not get at all the same interest from lectures; when a student works in a physical laboratory he gets interested in his work, and makes rapid progress. I have been almost inclined to think that for advanced students practical work with demonstrations would do away with the necessity of lectures altogether.

6888. What is the number of the students who are engaged in this practical work, and to what class do they ordinarily belong?—They are of different classes; some are students who have been sent home from India by the Government to get up theoretical knowledge of telegraphy, and these work principally at electrical work. We have had several of these students. And then there are others, matriculated students, who pay the occasional fees and do work in the physical laboratory, in addition to the other work that they have to do in the College—in some cases getting leave to omit certain parts of the regular course. Then there are other students that do not attend the regular lectures at the College, but come to the physical laboratory for practical work in different branches of physics, confining themselves generally to one or two branches. Some study all the branches of physics, and intend to compete for Natural Science Exhibitions at Oxford or Cambridge, and to become teachers of physics. Besides these, all third-year students of the Applied Science Department are admitted to a laboratory course. The numbers have been very high from the beginning. I was surprised to find, when we first started the laboratory, not expecting more than about 10, that there were 15 or 16 in the first week that the laboratory was opened; last term we had 24, and at the present time we have 21 students.

6889. Have you sufficient space for the convenient practical instruction of that number of students?—



Yes, but we have never had that number working all at once. In the large laboratory, 30 feet by 40, we could accommodate from 15 to 18 students conveniently, if they are working at different subjects. The principal pieces of apparatus must be fixed on the tables, and the students pass from one instrument to another as they master the subject in hand. With a large number working in one subject, it would be difficult to supply the necessary apparatus. Many experiments with delicate galvanometers it would be very difficult to make, on account of vibration, if there were so many students working at one time.

6890. What is the occupation of your third year's students as compared with those of previous years, or of occasional students?—In most of the subjects they have the same course as the second year's students with certain additions, for instance, of practical chemistry, practical physics, levelling, and photography. The other subjects are the same as for the second year's students. The usual plan is for the more advanced of the second and third years' students to have a course running through two years. In mechanics that is the case, and also in physics. In each of these subjects my lectures include one part of the subject during one year, and another part of the subject during the next year, the one bearing more particularly on civil engineering, and the other on mechanical engineering. In that way the lectures are not repeated over, and it is of advantage to the students to stay for the whole three years. Every class is open to occasional students who pay the fees for that class.

6891. Does the knowledge gained by the better students enable them to be advanced to posts of responsibility?—It is a fact that they are advanced to posts of responsibility after they leave us. There is no examination test which can be applied generally in the case of our students, because there are very few examinations indeed in which engineering enters as one of the subjects, but in two or three cases I think of, at the present moment, there are old students who have only left us for two or three years who are still apprenticed to large employers, and who are entrusted to make out plans and estimates for their employers, and to have the entire superintendence of the execution of important engineering works; others, who go abroad, are at once appointed to important posts, and sometimes with very good salaries.

6892. What is your opinion as to the capacity of the present staff of the College for preparing students by theoretical knowledge of physical science for positions in public engineering or telegraphy at home or abroad?—The present staff of the College is capable of giving students such theoretical knowledge. Our students are successful at the few examinations which are open to them. Thus, in two years, two students from the College have obtained Whitworth scholarships, and another was second below the line, 10 have been appointed to the Indian engineering service, and at the Universities, two have obtained Natural Science Exhibitions at St. John's College, Cambridge, two have obtained Natural Science Scholarships at Merton College, Oxford, and two have obtained honours in chemistry and physics at the First B. Sc. examinations of the University of London. We have every means at King's College that can be provided for the education of engineers, except the practical engineering itself, and for that it would be necessary that our students should go to a practical engineer to finish acquiring a knowledge of the profession, but we have everything preparatory to that in our present course at King's College; the course is complete for civil or for mechanical engineering.

6893. What is the number of matriculated and of occasional students?—The number in the Applied Science Department has generally been, within the last 10 years, from 75 to 95. We have reached 100, but during the last two terms the numbers have been considerably lower. That may probably be accounted for, because we have started another de-

partment—a modern division of the General Literature Department—which is new, and probably that has drawn off some students from the Applied Science Department. And another reason is, no doubt, the want of an opening for our applied science students. If students do not see any opening, of course, they will not come to the Applied Science Department for three years, and I have no doubt that the Applied Science Department has been lowered during the last two terms in consequence of the announcement of a new government college. In fact, I should think that that was the principal reason, because during the worst times of engineering our numbers did not go down; on the contrary, they continued to increase after 1866 until 1868. Although there was no opening at all for our students, yet they were increasing up to 1868, when I had 100 students in my own classes.

6894. You conceive that the proposed foundation of a Government College with a special view to public engineering would be likely to attract students from your courses into that College?—It would attract students at once if they thought that by entering that College they would be sure of appointments, whereas they would not get any appointments at all from King's College.

6895. As to the power of varying the course to be pursued by a matriculated student, will you describe what are the regulations of the College?—A matriculated student may omit some parts of the course. If a parent or guardian desires that any particular course or courses of lectures should be omitted, a student obtains leave from the Principal and omits that course or courses; also a matriculated student may study other subjects that are not included in his regular course, by paying the extra fees for those other subjects.

6896. Is there any definite course with reference to the matriculation examinations of the London University?—For the matriculation examination we have no definite course. In the modern division of the General Literature Department all the subjects are included except Greek, but we consider that the number of subjects is so great that we should not be giving so good an education if we were to include them all in any definite course, for a student would not be able to study each subject thoroughly, and so would get into the habit of "cramming" up his subjects. Still we have several from the College and the School who have passed in honours at this examination; and our courses enable students to pass in honours at the higher scientific examinations of the University of London.

6897. Regarding the general interests of high scientific instruction, is there any opinion which you would desire to express to the Commission as to the policy of founding Government Schools or any consequent compensation which ought to be made to colleges such as King's College?—I think it is very important that all colleges that are efficient should be put on the same basis, that where a college exists and does its work well, and that against great difficulties, especially where it is impossible for a department to exist by itself (such a department as Applied Sciences, for instance, at King's College, which could not exist by itself), in that case the Government would certainly be doing a great injury to engineering education generally, if it were to set up an institution which would ruin such colleges as King's College, and to apply its patronage to that institution alone. I think it is very important that all efficient colleges should not only be placed on the same basis with regard to the rewards open to students, whether by granting a certain number of nominations to each college or otherwise, but that in being able to secure as teachers men of the highest talent such colleges should not be placed at a disadvantage through the want of endowment.

6898. I understand you to mean that both as to the distribution of endowments or Government grants, and likewise as to the incentives to study by the distribution of patronage, you would wish that no special privileges should be enjoyed by schools founded by the Govern-

W. G. Adams,  
Esq., M.A.

20 March 1871.



W. G. Adams,  
Esq., M.A.  
20 March 1871.

ment alone, but that those privileges should be open to all efficient centres of scientific instruction?—Yes, that is my view.

6899. (*Sir John Lubbock.*) Are you aware that in consequence of the recent resolution of the House of Commons, the Government have determined to admit students from other colleges to compete for admission to the engineering service of India?—I heard that there was to be such an alteration, but I am not aware of the conditions.

6900. Of course, then, you have not looked at the conditions to see whether they are satisfactory to your mind?—No. I was not aware that additional conditions had been published. I may add that no conditions will be satisfactory to us, which compel our students to pass an examination for admission to the new College before they are allowed to compete for the Indian appointments. If such a preliminary examination is necessary, those students who pass above a qualifying standard should be allowed to continue their education at such colleges as King's College, and these examinations should in no way be connected with the new College. At any rate the diplomas which we grant as the results of our examinations should be received as equivalent to admission to the new College.

6901. What do you consider to be the reasons which have led to the fact that the existing institutions have not supplied the Indian Government with satisfactory candidates?—I think there is quite sufficient reason. Our better students did not take it into their heads to go in for Indian appointments until after the year 1866, when there was such depression in engineering in England. Before that time our students at King's College had no difficulty whatever in getting appointments; after working two or three years under engineers, they obtained better appointments at home.

6902. In fact, it comes to this, that the Indian Government did not before offer sufficient inducements in the shape of salary?—Quite so.

6903. But if they had raised the salary you think they might have obtained them?—I have no doubt that many of our students would have gone up for the examination, for I know that there was no objection to India as a field for engineering, in fact it was considered one of the best fields for engineering students.

6904. Without referring to King's College specially, I wish to ask you whether you consider that, if the Government had offered sufficient inducements, they could have supplied themselves, either from King's College or from the other educational institutions of the country, with satisfactory candidates for admission into the engineering service of India?—I think so. There would, of course, be a difficulty in getting a large number at once above a high qualifying standard, because when the students come to an engineering college they only stay for two or three years, and they come so unprepared that it is impossible in that short time to turn them out as first-rate mathematicians or with first-rate theoretical knowledge, therefore they would not reach a very high standard in two or three years, until the modern departments of public and private schools, which supply colleges like King's College, or University College, or Owens College, are of a higher character.

6905. Then, in point of fact, you do not consider that the existing educational institutions could have supplied the requirements of the Indian Government in that respect?—I do not think there is any means of getting them at present in large numbers until we can keep students longer at the places of education before they enter on their pupilage. I believe that we have the means, and all the means that can be supplied by the Government.

6906. The proposed course at Cooper's Hill College is one of three years, is it not?—Yes.

6907. In your opinion that would prove to be insufficient to obtain a first-rate engineering education?—I think so: unless the students have gone

through a previous course of training at scientific colleges for two or three years, their standard will not be what I suppose it is expected to be; it will not be a high standard, certainly.

6908. Are you acquainted with the steps which have been taken to teach practical engineering in the proposed Government College?—It is proposed to place the students with an engineer, I believe, during one year of the course. During the last three or four years some of our successful students in the Engineering Department, who have gone to India, have followed that course; they have stayed with us at King's College for two or three years, they have then gone with a practical engineer for one or two years, and then have passed the examination, so that they have had all the training that it is proposed to give them in the new engineering college.

6909. I presume that in your opinion there would have been no difficulty in carrying that out on a more extended scale, if it had been suggested by the Indian Government as desirable?—Not the slightest difficulty.

6910. You are probably aware that the Indian Government have proposed to raise the salary of engineers when they first go out from 240*l.* to 420*l.*?—Yes.

6911. Do you not think that so large an increase must have a very material effect?—It must draw engineering students in that direction.

6912. Do you think that that salary of 420*l.* would in past years have been sufficient to have induced satisfactory candidates to apply for the different appointments?—I think it would; it would have brought up a higher class of candidates.

6913. Would it be possible, do you think, by means of any competitive examination, to compare fairly the merits and acquirements of those who have been educated at King's College, or at University College, with those who have received the latter parts of their education at the proposed Cooper's Hill College?—Yes, certainly, as to the theoretical part of the examination.

6914. But with regard to practical knowledge, what is your opinion?—It is rather difficult for me to say with regard to the examination in practical subjects, because my own studies are mostly theoretical, and therefore I do not think that I could say how far it would be possible. It is my opinion that our professors in practical subjects would have no difficulty in picking out the best men. In practical physics I should have no difficulty.

6915. You have already stated your opinion that the mere proposal to found one Government institution has had already a prejudicial effect upon the numbers studying at King's College?—Yes. It certainly has turned some from the Applied Science Department into another department—the Modern Division—where they thought that the course of work was better suited for the entrance examination for the new engineering college.

6916. (*Professor Huxley.*) I understood from you just now that you consider that the defective state of secondary education in England has been a very great obstacle to giving thorough scientific instruction in King's College?—That is certainly a very great obstacle. On entering the College, the majority of our students only know something of algebra, and in many cases a very small quantity of algebra, and they know no mechanics whatever. If a student knows a little of trigonometry and something of mechanics, we consider that he is one of the best that we generally get.

6917. Do you yourself think that there is the least difficulty in introducing a very much greater quantity of scientific instruction into secondary schools, so as to enable young men to take advantage of your higher instruction?—I think that there would be no difficulty in introducing a greater quantity of scientific instruction, as it is being introduced into the modern departments in schools. The result has not been very successful hitherto, but I believe that it might be.



6918. (*Mr. Samuelson.*) Are you under the same government in the College as in the School?—Yes.

6919. Is there any correspondence or any connexion as regards the students between the School and the College?—There is some connexion. The School consists of two parts, the classical and the modern department, and the connexion is not very intimate, but pupils who have been for more than two years in the School have the advantage that they are considered to have completed their course in the Applied Department in the College after two years instead of three. At the end of the second year such students have the advantages which other students usually have at the end of three years.

6920. What amount of science is taught in the school?—There are in physics about three lectures a week to the higher classes of the modern division, and there is one lecture in chemistry, and also practical chemistry is taught. Physics is taught by the Demonstrator of Physics, by experimental lectures, and also by correcting essays written by the boys.

6921. Do you find in practice that this course in the School justifies the curtailment of the College course by one year?—Generally the boys from the school are very well prepared, and we find that they are among the best of our students at the end of the second year, and they frequently carry off our prizes.

6922. To what per-centage is the School a feeder of the College in the Applied Science Department?—To a small extent; the per-centage would be small. We should have probably not more than eight or ten at one time from the Modern Division of the school in the Applied Science Department.

6923. That would not be above one tenth of the number?—Just so.

6924. Can you account for the per-centage being so small?—I cannot account for it, except that the boys in the Modern Division of the School leave at an early age and go into business very frequently. I think there is no reason why it should not be very much higher than it is.

6925. If you had a matriculation examination, would it not be possible to exact attendance at the School from those who were not up to the standard of examination when they came to you?—It would be, but students would not come in many cases under those conditions. They would probably not enter the College at all, but go elsewhere.

6926. You mean that they would go to institutions where no such condition was imposed?—Yes; or to a private tutor, and perhaps remain with him instead of coming to us.

6927. That would apply, would it not, equally to a matriculation examination without any such condition?—Yes. As there is no strict matriculation examination, they are admitted into the College, and it is necessary for some of the staff of teachers to spend their time on a low class of students who know very little.

6928. You would be at a disadvantage, would you not, with regard to the number of students entering if you imposed a matriculation examination, and other institutions did not do so?—We should.

6929. What is the average age of entry in the College?—16.

6930. You spoke of the want of employment in civil engineering since 1866, but has there not been a considerable increase of employment in mechanical engineering and the allied arts?—I have heard lately that in mechanical engineering there is abundance of employment, and several of our students are with mechanical engineers.

6931. Do you mean that they are employed with them at the same time as they are studying with you?—No; after they leave us they go to their practical work.

6932. Has it been objected at all that, in consequence of the age at which students leave King's College, there is difficulty in setting them to practical work as mechanical engineers?—I have not heard that objection at all. In fact, I think that that is not

the case—that the principal civil and mechanical engineers prefer to have students who have been at the College for three years rather than a less time, and I know that they advise our students to remain at the College for three years.

6933. That arises, I suppose, in part from your having a workshop in which they learn the rudiments of the art of mechanical engineering?—Yes; they are able to use tools, and even to make machines and steam engines for themselves before they leave us; they are probably preferred because they are better educated.

6934. Are you able to say whether they are generally considered to be fair workmen when they leave you?—I suppose they would hardly be called in the profession fair workmen, but as students I should say that they are capable of doing very good work.

6935. Do you suppose that they can do as good work as boys who have served one year of their apprenticeship in engineering works?—I should think they would do better, because they have gone through a thorough course of study in wood work for a year, and then a thorough course of study in metal work for two years. In some cases a student pays more attention to wood work, and he goes on with it in his second year.

6936. As a rule is the term of their apprenticeship with mechanical engineers curtailed at all, in consequence of the practice which they have acquired in your workshop?—I cannot say whether that is the case or not.

6937. But they are liked as apprentices?—Yes.

6938. You stated that before 1866 the demand for engineers in this country was so great that there was little temptation for your students to compete for the Indian appointments?—The majority of our students stayed at home, and studied the practice of civil or mechanical engineering under English engineers, others went abroad, to France or to Russia, where they were at once appointed to posts of importance; I know of two or three cases in a single year, in which students received salaries of 500*l.* a year at once, or very soon after they had left the College. In these cases the students had been with us for three years. Students have also come to us from Spanish America, and have returned to their own country to be employed on engineering works.

6939. Are you referring more especially to the period before or after 1866?—I am speaking of the time before 1866.

6940. But the number of public works on the Continent and in America has increased very much since 1866?—I was not aware of that. The cases that I had in my memory were cases that occurred before 1866. I do not think that the number of our students from Spanish America has increased; we have generally had two or three in each year, but I do not think that the number has increased since 1866.

6941. You stated that before 1866 there was less temptation than there has been since that time to compete for the Indian appointments, but five years have elapsed since then, and one would think that if there were competent persons for such appointments, they would have competed during that interval, unless there had been some other cause preventing them than the demand in other quarters?—Some of our students who have gone in for this examination for India since 1866, would not have entered at all previously, but would have remained with engineers in England, but as there was nothing better doing, and not likely to be for some time, that was really the reason why our better students have gone to India.

6942. Have there been many cases of your students going to India?—There have been 16 in the last four years, and in the last two years 10 out of the 35 successful students have been from King's College.

6943. Do you think really that the small salary offered has been the reason why good men have not competed, seeing that employment has been so scarce at home, and that there was a certainty of rapid pro-

*W. G. Adams,  
Esq., M.A.*

20 March 1871.



W. G. Adams,  
Esq., M.A.

20 March 1871.

motion in India?—I think that has been the reason why students have not gone; and in fact I have heard students speak of it as not worth their while at all to try for the appointments; in some cases I have known, the students preferred to go to India as engineers unconnected with the Government.

6944. As engineers to contractors?—Yes.

6945. And have they also received higher pay from the commencement?—I cannot speak as to the pay that they received. They considered it a better opening.

6946. In the case of persons competing for those Indian engineering appointments, I believe it was a condition of the competition that they should have served an apprenticeship, in addition to being able to satisfy the examiners in theory. Are you aware whether that was so?—I am not aware whether an apprenticeship was necessary. Students who have been two years in the Applied Science Department of King's College, and one year in practice under a civil or mechanical engineer, were admitted by the Secretary of State for India to be candidates for appointments to the engineering establishment in India. This privilege has now been virtually withdrawn without any intimation from the Secretary of State for India.

6947. If it were so, would many of your students have been able to satisfy that double qualification?—Yes, they were always apprenticed with an engineer after they left us. Those who went up for examination always were with an engineer for one or two years after they left the College.

6948. Was there any difficulty in their obtaining leave to enter an engineer's office for so short a time as one or two years?—I think not. They generally studied under a Professor of the College who is a civil engineer.

6949. I believe it is proposed that the fee at the Indian Civil Engineering College is to be 150*l.* per annum?—Yes.

6950. And it is estimated that the expenses of the College will be covered by 150 students paying that fee?—Yes.

6951. Do you think that there is any probability of 150 students being prepared to pay that fee residing there at one time?—I do not think that the number will be obtained for some time to come; that is to say, not prepared in any way for any high course of study. I think it will be some time before that number will be reached.

6952. Even if there were 150 persons prepared to pay the fee, you do not think that they would be sufficiently advanced to profit by the instruction in the College?—No, I think the instruction in the College would have to be lowered down to the standard to which we are obliged to lower it at other engineering colleges.

6953. That fee was fixed at a time when it was contemplated that this College should be the only avenue to civil engineering appointments in India?—If the change which has been made should be *bonâ fide*, namely, that students from other institutions shall be permitted to compete, do you think it will be equally easy then to obtain 150 students as it would under the condition first contemplated?—Certainly not; the students will remain at the other institutions.

6954. So that, assuming that a sufficient number of well-prepared young men can be found, they are not likely, in your opinion, to enter there in sufficient numbers if they are to pay 150*l.* a year, and have no special advantage in the competition for appointments?—No, I think not.

6955. And the dilemma then will be this, either that they must give special advantages to the students, or that their College will not have those 150 students at 150*l.* a year, and consequently will not be self-supporting?—Yes, I should expect that, certainly.

6956. (Professor Stokes.) You spoke, did you not, of the staff of King's College as being insufficient?—Not insufficient for the present work, but I should say that the staff is overworked, rather than insufficient.

6957. But worked in such a manner as to prevent the Professors having any time for original research?—Yes, entirely so. My own work keeps me at the College every day from 10 till 4, and I am working hard the whole time; the teaching in the laboratory is just as trying as lecturing, or any other kind of teaching, so that after that time in the day spent in teaching, it is impossible to do much original work.

6958. Do you think that the individual teaching which is given in the laboratory is of such a nature that it could be carried on by a Demonstrator working under the general superintendence of the Professor, and possibly applying to him in any case of difficulty?—That is possible, and is the plan which we adopt. I have a Demonstrator in the physical laboratory, and we divide the work, but frequently it is quite enough for both of us to do to superintend the work of the students in the laboratory. If there are 9 or 10 students, as I frequently have, it is quite necessary that both should be teaching, going from one to another, and making suggestions as they may be required.

6959. You think that one man could not properly superintend in the laboratory more than about five students?—Perhaps one man might be able to attend to seven or eight students, working at the same time.

6960. If there were a larger number of students it would require rather a large staff of Demonstrators to set the Professor free as regards a certain portion of his time for original research?—Yes; if it were possible it would be very important indeed to allow the Professor as well as the Demonstrator to confine his attention to a particular part, but of course in such a college as King's College that is quite impossible. I should have said that in connexion with the laboratory we have other assistance as well. I have always a workman who repairs and makes instruments for me, and in addition to that a laboratory assistant, so that the Demonstrator has nothing to do in the laboratory but with the teaching.

6961. Is there any difficulty in finding demonstrators who would be willing to work for a short time, partly for their own advantage, I mean in making themselves better acquainted with the subject, for a small remuneration?—With us there would be a difficulty. In some cases our advanced students might be able to take that position. Some stay with us and work in the laboratory for two years, and in the second year they are able to go on with some original work, but they are mostly too young to assist in teaching.

6962. (Dr. Sharpey.) Will you tell the Commission what is the amount of fees which a student is required to pay per annum in the Applied Science Department in King's College?—45*l.* a year is the average sum. In the first two years it is 42*l.* per year, and there is in addition a matriculation fee of nearly 6*l.*, and in the third year the fee is 45*l.*, so that the average is 45*l.* for each of the three years.

6963. Are there any extras that they have to pay in the way of apparatus or anything of that sort?—In the regular course they have nothing extra to pay; they would have to pay 10*s.* a term, for the use of acids and batteries in the physical laboratory.

6964. About 10*s.* a term would meet that?—Yes, that sum was charged, because in the first three or four terms it was found to cover the expenses.

6965. Did the College receive anything from outside towards the expense of establishing the physical laboratory?—Nothing.

6966. Was it entirely through the resources of the College itself that it was instituted?—Entirely so.

6967. Could you state approximately what the cost was?—The cost was about 2,000*l.*, I believe, for the new chemical laboratory, and the physical laboratory, which were established at the same time. The rooms for the physical laboratory were fitted up according to a plan which I laid before the council, and a sum of 300*l.* was placed at my disposal for new apparatus. I have also a yearly grant of from 30*l.* to 40*l.* for lecture expenses.

6968. Who gives instruction in the workshop?—



Mr. Timme, the Superintendent of the workshop. He was Curator of the Museum of Natural Philosophy for many years, and he has been for a great many years Superintendent of the workshop.

6969. With reference to engineering and other practical studies of a similar nature, what would you think of the expediency, in regard to Government appointments, of establishing institutions for communicating the special practical instruction which is required for the particular duties that engineers and others would have to perform for the Government, and allowing the candidates to receive general systematic instruction in mathematics, in physics, in chemistry, and in other general scientific studies wherever they choose to find it, but testing their competency in this theoretical instruction by a thorough examination before they are admitted to the special practical courses of instruction in the Government institution?—I think it would be well that the education in the more practical subjects, as well as in the theoretical scientific subjects, should be carried on at the Colleges. A student can only learn the practice of engineering under a practical engineer, and no Government institution could supply more than could be supplied at such colleges as already exist; therefore I do not think that it would be any advantage to separate the practical work from the theoretical, or to establish Government institutions for giving special practical instruction. Often there is great advantage from carrying on the practical side by side with the theoretical; for instance, students make joints and different pieces of machinery in the workshop, and make drawings from similar joints in the drawing class room, and so those different parts of the teaching work into one another. Then, again, when I am teaching them practical mechanics and the principles of mechanism, they are also attending lectures on the details of machinery and of mechanical engineering, and can apply the knowledge so gained to their work in the drawing class room, and in the workshop, so that their work in the workshop is intimately connected with the lectures on mechanics, on manufacturing art and machinery, and on drawing.

6970. But do you not think that there is a certain amount of preparatory general scientific instruction which is common to many practical pursuits, the previous acquisition of which might be obtained adequately in any competent college, and that there would be a saving of public money if Government schools of applied science were relieved from the charge of such general courses of instruction?—Certainly. There are existing colleges in which such scientific instruction in mathematics, chemistry, and physics is given, and it would be a saving of public money to help these colleges rather than attach the same kind of teaching to other institutions. It would also be a great saving of public money to pay part of the salaries of the professors in those unendowed colleges where practical subjects are taught successfully, rather than to keep up professorships and expensive technical schools which do not succeed.

6971. My question had reference to mathematics, physics, and general chemistry, quite apart from engineering, mining, or metallurgy?—I think that every school of mathematics, chemistry, and physics should give students a knowledge of the theoretical subjects that are required for Government appointments, and that it is unnecessary that the teaching of such subjects should be carried on in any Government institution, when existing colleges could supply all the demand for such teaching.

6972. And then, by subjecting the candidates for the Government institution to a previous examination, both theoretical and practical, their fitness to enter it might be tested?—Yes, certainly it might be tested by proper examination.

6973. (*Chairman.*) Probably you are aware that the ordinary mode hitherto adopted in England of training for the professions of mechanical and civil engineering, has been by a young man entering the office of a civil engineer, and acquiring there what-

ever information he required for his profession?—Yes.

6974. Without much previous preparation?—Yes.

6975. You have also stated to the Commission that the young men who have acquired at King's College whatever theoretic instruction they could in the three years' course, have not unfrequently gone for two years subsequently into an engineer's office?—Yes.

6976. Has the practice arisen of alternating the course at the College with a year in an engineer's office, and returning to the theoretic course in the College after that practical application of previously acquired scientific knowledge?—It has generally been considered better that they should have the theoretical knowledge first. I remember one case where a student was sent to us from the Crewe Works. He went to the Crewe Works, and it was thought better that he should have more theoretical knowledge first, and Mr. Ramsbottom advised that he should be sent to King's College for two years, and then come back to the works. He was sent to us during what would have been the term of his apprenticeship by Mr. Ramsbottom's advice.

6977. Had that student received any previous practical instruction, either at the Crewe Works or elsewhere?—I believe none before entering the Crewe Works.

6978. Is the course of instruction so ordered at King's College that the student could spend part of his time in pursuing theoretic studies, and the other part of his time in any of the engineering works of London?—We have no such arrangement.

6979. You are aware that something of that kind is contemplated in the preparation for the scholarships, and prizes, and exhibitions, which have been offered by Sir Joseph Whitworth; there is contemplated an alternation of a year of practical work with the same period of theoretic study?—Yes.

6980. Do you think it would be impossible so to order some portion of the course at King's College, as that young men acquiring a practical knowledge in some engineering works in London, could either take an alternate year of theoretic study, or portions of the same year in theoretic studies in the College?—There would be no difficulty whatever. With regard to the Whitworth scholarships I should say that one of the practical men who was successful in the first competition has been to us for two years since, so that he had his practical teaching first, and now he has been with us for two years having his theoretical teaching, and we have had just the opposite cases. There were two of our first students in the physical laboratory, who were successful as Whitworth scholars in the first year, and they had not had their practical teaching previously.

6981. Still keeping your mind fixed for the moment on the subject of the alternation of practical and theoretical work, if you have the full power so to order the courses, would you prefer that the practical knowledge should be attained in an engineer's shop in connexion with such alternations, or would you prefer that it should be attained in the workshop of the College?—I believe that the use of tools may be thoroughly taught in the workshop in connexion with the College; indeed quite as well as in an engineering workshop. It would be very objectionable that a student should leave his college and his theoretical work for a portion of the year to go to an engineering workshop, and then return to his college again as a student.

6982. So that you would rather desire that the workshop, in which a thorough knowledge of the use of tools should be obtained, should have immediate connexion with the theoretic courses of the College?—I would.

6983. I need scarcely ask you whether you would desire that the present imperfect course of instruction, by entering an engineer's office, should cease and be substituted by a course in which high theoretic instruction should be obtained—in whatever way the practical

W. G. Adams,  
Esq., M.A.

20 March 1871.



W. G. Adams,  
Esq., M.A.

20 March 1871.

instruction was afterwards secured?—Most certainly; the theoretical instruction is necessary.

6984. By the adoption of one or the other of those plans, no doubt, if proper resources were placed at your disposal with a sufficient preliminary education, you could prepare young men for any official engineering appointments which might be offered for their competition?—We could.

6985. So that you do not contemplate, as a matter of necessity, the creation of schools endowed by Government patronage and with endowments which are not possessed by King's College?—Certainly not.

6986. Is there any other matter which you would desire to communicate to the Commission in relation to your examination?—There is one point which, perhaps, I ought to state to the Commission, because I know that remarks have been made in public in connexion with it, and it is well that the matter should be thoroughly understood. I mean with regard to the religious question in connexion with King's College. I would just state, with reference to the attendance at chapel, and also with reference to the divinity lectures, that the principle adopted at King's College is that the attendance at chapel shall be entirely voluntary. In fact the attendance of students is not marked, so that there is no means at all of knowing whether a student is present at the chapel service or not, because it is considered that religion should be a voluntary matter. Then with regard to the lectures on divinity, what I said with regard to other lectures in each definite course is also true of the lectures in divinity, that in cases where the parent or guardian desires that a student should omit any particular course, leave is granted to the student to omit that particular course. That applies to any class in any definite course of study.

6987. (*Professor Huxley*.) Is it not the case that in King's College a professor must be a member of the Church of England?—Yes; but no test is applied.

6988. But it is understood that he shall be a member of the Church of England?—Yes.

6989. (*Mr. Samuelson*.) Is it stated definitely in the prospectus of the College that attendance at chapel is not required?—I think not.

6990. But, on the other hand, it is definitely stated, is it not, and dwelt upon in the prospectus, that the College is a Church of England institution?—Certainly; and it is a Church of England institution undoubtedly.

6991. (*Professor Huxley*.) Will you have the kindness to state what you do in the way of evening classes with regard to science?—A great number of subjects are included in the evening class course. There are lectures on mechanics, physiology, chemistry, practical chemistry, botany, experimental physics, mineralogy, geology, zoology, mathematics, and many other subjects. We have a winter course and a summer course, the winter course extending from October to Easter; and the summer course being for one term, from Easter to July. Throughout the winter course there are generally two lectures a week in each subject taught on two evenings in the week; in mathematics there would be four lectures in the week, and in experimental physics there would be one.

6992. Is there any laboratory practice in connexion with those courses?—At present there is in practical chemistry, but not in practical physics. It has been proposed to have demonstrations in practical physics,

but a sufficient number of students did not present themselves for laboratory practice, and therefore the course was not begun.

6993. Are the courses conducted by the Professors of the College?—Yes, they are conducted by the Professors of the College in some cases, and by others who are not otherwise connected with the College. In the year the number generally attending the evening classes is from 500 to 600, and in past years we have had 600 and 700.

6994. Will you state what would be the average number attending the principal classes in the evening?—I should think 20 attending each class.

6995. (*Mr. Samuelson*.) Are you aware whether many young men serving an apprenticeship to civil engineering or to some branch of practical chemistry or some chemical art, are attendants at your evening classes?—There would be some, but I should think the generality of the students would be those who are clerks in offices, apprentices, assistants to chemists, and others, who are engaged in actual work during the day.

6996. You do not consider that those classes exert any considerable influence upon the education of young men serving apprenticeships, either as engineers or as manufacturing chemists?—I think not. If there were a great demand for more technical classes, I have no doubt we should establish them at once; and an attempt has been made to arrange courses of technical instruction in connection with the evening classes.

6997. With regard to the religious question, has your attention been called to the general rule for all matriculated students contained in the Calendar, to the effect that they are required to attend the daily service in the chapel at 10 a.m., unless they are especially exempted by the Principal?—What I stated is the case, that the attendance of students in the chapel is not marked at all, and there is no means of knowing whether a student is present at the College chapel or not.

6998. Will you refer to page 64 of the Calendar for 1869–70, where you will see what I have just read?—I can positively state that that is no longer the case, and that the regulation which I have described was introduced when the present Principal entered the College. He was entirely opposed to the principle of marking students for attendance at chapel, and this, I have no doubt, was an old regulation which was in force, and which has not been removed from the Calendar.

6999. That is to say, that the regulation which demands attendance from the matriculated students is not enforced, but on the other hand the non-enforcement of that regulation has not been brought to the knowledge of the public?—Yes, that it still occurs in the Calendar is an oversight, I have no doubt.

7000. And do you believe that it would be removed from the Calendar if the attention of the Principal were called to it?—I believe so.

7001. Would the Principal have power to remove it without the sanction of the Governing Body?—The Principal has the power to excuse any student from attendance at chapel.

7002. (*Chairman*.) Is there any other point which you would like to state to the Commission?—I do not remember any other point.

The witness withdrew

JOHN WILLIAM CUNNINGHAM, Esq., examined.

J. W.  
Cunningham,  
Esq.

7003. (*Chairman*.) I believe you are Secretary of King's College, London?—I am.

7004. And have been so since 1845?—Yes.

7005. When was the College founded?—In 1829.

7006. The site, I believe, was granted by the Crown? Will you describe the various resources by means of which the College was erected?—The site was granted by the Crown, and the College was erected by money raised partly by shares and partly by donations.

7007. Was there any grant from the Government towards it?—For the site only, nothing towards the building; it was a waste piece of land close to Somerset House.

7008. Will you inform the Commission in what way the College is governed?—It is governed wholly by a Council, consisting altogether of 42 members, nine of whom are official members, eight are life members, and the other 24, together with the Treasurer, are elected by the shareholders and subscribers at



their annual meeting, six of them going out every fourth year.

7009. Who are the Official Governors?—The Lord Chancellor, the Archbishop of York, the Bishop of London, the Lord Chief Justice of the Queen's Bench, the Secretary of State for the Home Department, the Speaker of the House of Commons, the Lord Mayor, the Dean of St. Paul's, and the Dean of Westminster.

7010. By whom are the Life Governors appointed?—By the Archbishop of Canterbury, for the time being, as vacancies occur.

7011. Is there any qualification for the elected members?—They are obliged to be either shareholders or subscribers to the College.

7012. Are they not required to be members of the Church of England?—They are by the charter.

7013. Does the College enjoy any endowments for its general purposes beyond the building?—None whatever. We have about 21,500*l.* which old friends have left us for prizes, scholarships, and professorships, but the College has no foundation at all applicable to its ordinary everyday work.

7014. The ordinary everyday work is supported solely by the fees paid by the students?—Solely.

7015. First the College has a General Literature Department?—Yes.

7016. How many students attend that department?—Altogether, in the two divisions of it, about 100—70 in what we call the classical division, and 30 in the modern division.

7017. Will you state the studies in the classical department?—In the classical department are included classics, mathematics, modern history, English, French, and German.

7018. In the modern division what are the studies?—Mathematics, natural philosophy, chemistry, history, English, French, German, and geology.

7019. There is also an Applied Science Department?—Yes.

7020. How many students ordinarily attend it?—About 80.

7021. What are the subjects of study?—Mathematics, chemistry, natural philosophy, mineralogy, geology, surveying, manufacturing art and machinery, the art of construction in earthwork, wood, and iron, geometrical, architectural, and engineering drawing, and the engineering workshops; and for the senior students, practical physics, and practical chemistry.

7022. The senior students are taught likewise in laboratories which have been specially fitted up at considerable cost, and are exempt from the study of certain other subjects?—They are.

7023. Have you a Museum?—Yes, a very large museum of philosophical and mechanical instruments, and another of mineralogy and chemical productions.

7024. Is there not likewise connected with the College a Medical Department?—Yes.

7025. How many students attend that course?—About 140.

7026. The course includes all the subjects of theoretic science connected with the study of medicine, and likewise the practical studies of the art?—Yes.

7027. You have, I apprehend, an Anatomical Museum?—Yes, and dissecting rooms, and a special library.

7028. Have you made any recent addition to the course of studies in this department?—We have done so within the last six months on an order received from the College of Surgeons, that before the next summer we must add to the curriculum a course of practical physiology. We have never had such a course before.

7029. Are you about to provide special buildings and fittings for that purpose?—We hope so, if we can get the site and the funds for it.

7030. Besides those general courses, you have likewise evening classes. Will you describe what they are, and what is the number of students attending them?—There are altogether about 550 separate students, who attend very nearly two classes each. There are 31 separate subjects of study, and out of the 550 men, altogether attending about 1,200 classes, about 300 are

attending science classes. In mathematics there are 72 students, in chemistry 41, in practical chemistry 33, in mechanics 35, in experimental physics 20, in mineralogy 15, in geology 15, in physiology 29, in arithmetic 30, and in drawing 20.

7031. To what classes in life do those students belong?—They are ordinarily clerks, either in public offices or in insurance, mercantile, architects', or engineers' offices.

7032. Will you describe the School which is connected with King's College?—We have a School which is divided into three parts, numbering altogether 430 boys. First of all, there is a Classical Division, doing much the same work as the Literature Department in the College. Then there are about 175 boys doing "modern" work, and a lower school of about 150 boys.

7033. Are the College workshops open to the boys of any part of this division?—Yes, to the modern division.

7034. Do many of the boys in the King's College School go through a course which will enable them to enter into the Applied Science Department of the College?—The whole of our modern boys do so.

7035. How many enter the Applied Science Department annually from the school?—I should think from 15 to 20.

7036. Is there any matriculation examination on their entrance into the Applied Science Department?—A very slight one—only for the sake of classifying the students. There is no examination which really keeps anyone out of the department.

7037. What are the chief impediments to the success of the College?—Simply that it is so extremely poor. Our original subscriptions were 15,000*l.* short of the sum that was actually wanted for the building, and although the Council has for many years insisted on putting by 500*l.* a year to pay off the debt, yet the increase of new wants has been so great that the original debt remains very much the same now as it did originally.

7038. What has been the chief source of any permanent outlay of late years?—Science in all its departments. In the first place the Council only a few years ago spent 5,000*l.* in building a new hospital, with the simple object, as far as they were concerned, of providing clinical teaching for their medical students. Within the last five years they have spent 2,000*l.* on a new museum, and 2,000*l.* on chemical and physical laboratories. And now, at the present moment, they have a further demand of, I suppose, 1,500*l.* more for the new subject of practical physiology to which I have referred.

7039. Besides which you have expended something on apparatus, have you not?—At the very last meeting of the Council there was a sum of 200*l.* voted for microscopes for practical physiology. In fact, they have new demands upon them every time they meet.

7040. Do the Scientific Departments as a matter of profit and loss add to the resources of the college?—No, I am afraid not; they certainly do not pay, and I am afraid in no possible way can we make them pay. The Medical Department is always worked at a very heavy loss, and the Applied Sciences Department does no more than just pay its own way, without adding one farthing to the resources of the College.

7041. Upon what principle is the teaching staff throughout the College paid?—On the principle of dividing amongst the members of each department three-fourths of the fees paid by its own students, the College reserving to itself the other one-fourth, out of which they have to pay the whole expenses of buildings, clerks, secretary, the Principal, repairs, gas, interest on debt, &c. But it sometimes happens that a part of the three-fourths given to the professors is taken away from them. The Council have for the last 10 or 12 years insisted on there being 500*l.* clear profit made every year, and if that clear profit is not made the professors have to make good the deficiency out of their next fees. This time last year the Council had to charge three per cent. upon the whole staff to

J. W.  
Cunningham,  
Esq.

20 March 1871.



J. W.  
Cunningham,  
Esq.

20 March 1871.

cover the deficiency of 1869, and this year they have had to charge one and a half per cent. for the expenses of 1870.

7042. So that whilst you have been struggling under very great difficulties on account of the original debt and the insufficiency of your resources to keep pace with the demands for scientific instruction of the country, you have not been able to make both ends satisfactorily meet?—No, we have not.

7043. If institutions were founded by the Government receiving resources by endowments or grants from the State, and likewise promoted by the application of the patronage of the State to their most meritorious students, would you consider that to be likely to injure the prosperity of your College?—Very greatly, and it has already injured us. The institutions which have been founded by the Government, one after the other, have drawn off students from us. Their fees are far lower, the salaries paid to their professors are far higher, and they spend an enormous sum every year in appliances and in advertisements; whilst we grumble over a single advertisement, we see a continual flow of public announcements coming from Government institutions; and now a fresh injury is likely to be inflicted on us by the establishment of Cooper's Hill College, which will most undoubtedly injure us extremely, both by taking off our students and by taking away our rewards.

7044. You conceive that your own previous labours in the advancement of scientific instruction entitle you to at least as much encouragement in the way of pecuniary advantages and patronage as that which is extended to any special college?—Yes.

7045. Has your College of late gained any of the appointments which have been offered by Government?—We have gained in the last four years 16 of the Indian engineering appointments, and such rewards will, of course, under this new plan, be all taken away from us.

7046. What are the alternative means by which the College can hope to remedy its present impecuniosity?—In the first place by adding to its fees, and in the face of the competition that we have to meet everywhere, more particularly in colleges and schools which are highly endowed, there is a very strong feeling amongst us that to add to the fees would be to take away from, rather than to add to, our funds. The second alternative is by diminishing our expenses, and this we already do in every possible way. There is scarcely ever a meeting of the Council at which an application for an increase of salary is not necessarily refused, always with pain and regret, most commonly with an acknowledgment that the applicant is underpaid; but the Council cannot help it, they cannot offer any more, and they certainly have reduced their expenses to the very utmost of their power. The third mode is by obtaining an endowment fund. The Council last year put forth a scheme, which they hope to carry out ultimately, of raising 30,000*l.* If they only succeed in raising that 30,000*l.* their position would be quite safe and healthy; but at the present moment all the circumstances of last year, the French war and the begging that went on in the winter for the French and German armies, have entirely destroyed all prospect of collecting it; but ultimately I hope that we may succeed.

7047. In what way would you apply the interest arising from the 30,000*l.*?—Partly in gradual liquidation of the 15,000*l.* that we already owe, and partly in fresh appliances, which are being asked for constantly.

7048. With reference to the religious regulations of the College, are the classes open to the students of all denominations, with the exception of those in the theological department, which are specially intended for educating students for the ministry of the Church of England?—Yes, the whole of them, both in the School and in the College.

7049. Is the regulation as to attendance on prayers, practically, insisted upon?—It is not insisted upon.

Our students are invited, but not required to attend. The attendance is not "marked" in any way.

7050. To what extent do the students avail themselves of that service?—I can hardly tell that. The Principal will be able to tell you better than I can. I am not able to be present myself. A large number do attend every morning; practically, the whole School goes, and I should think about half the members of the College.

7051. What are the regulations as to the divinity lecture which is given in each week?—Any student who applies to the Principal to be let off on the ground of religion is exempted from attendance, but otherwise all matriculated students are expected to attend.

7052. And, of course, there is no distinction made in the privileges of a person so exempted and a person who attends?—None, as to the advantages of lectures.

7053. As to the occasional students, are they equally required or expected to attend chapel?—No, they simply enter for certain classes, and attend only those classes.

7054. That applies likewise to the School, does it not?—Yes, it applies to the School also. We have always a certain number claiming exemption. My own son is a Master in the School, and he told me only this morning that he had three boys in his class now who were exempted from chapel on account of religious opinions. One is a Jew, a second is a Parsee, and the third is half a Parsee, his father being a Parsee and his mother a Christian.

7055. I understand you, therefore, to represent that no application for admission to the College is ever refused except on other than religious grounds, nor is the student subject to any disadvantage in the College, because of his non-attendance either upon chapel or the divinity lectures?—As far as the lectures go that is so.

7056. Is he subjected to any other form of disability?—The only thing that he cannot get is the Associateship. At the end of his three years' course, unless he has been regular in his attendance on the divinity lectures, he cannot obtain the Associateship of the College.

7057. Has the history of the College, in your mind, established its claim to public support?—Yes.

7058. Will you state what you conceive to be the main grounds of that claim?—First of all, the very large educational work on which we are engaged. I do not think that there is any other institution in the kingdom which does so much, and which has so many separate departments at work by day and by night as we have. We have the largest educational work going on anywhere. Secondly, the immense difficulty of carrying it on with such very small funds as we possess. Thirdly, the new wants every day coming up which we really cannot meet. Lastly, the very large number of honours gained at the Universities by the students of King's College.

7059. And you especially object, under the circumstances in which you are found, in consideration of the work which you have already accomplished with no other aid than the grant of the original site from the Government, to being subjected to the competition of schools whose resources are annually aided, and which have a larger share than you have of the patronage of the Government?—Yes; very strongly.

7060. (*Sir John Lubbock.*) Did the Government communicate with your Council before founding the Cooper's Hill College with the view of ascertaining if you would endeavour to increase the number of candidates for those Indian appointments?—No, in no way. We have applied to them since, complaining of their action in that matter; but we had no previous communication from them of any sort or kind. We should have told them at once that if they would only let us know what the work was that they were anxious to have done, we were perfectly prepared to undertake it.

7061. And if they had pointed out to you the number of applicants whom they wished to send out, and the qualifications which they required, you think that it would have been possible for you to have, at any rate,



gone a considerable way towards meeting the requirements of the case?—Yes; more particularly if they had granted the increase of salary which they are to grant now to the Cooper's Hill men.

7062. You attach very considerable importance, do you not, to that increase of salary?—Yes.

7063. And assuming that they were prepared to give that annual increase of salary, even without any other additional assistance, I understand you to say that you consider that King's College could have gone very far towards supplying the deficiency?—Yes.

7064. I presume that, to a certain extent, the undesirability of the College will be removed now that the Government have consented to admit other candidates by examination as well as those who have been educated in the Cooper's Hill College?—We hardly know yet how that can possibly be carried out. If other men are allowed to compete with the students of Cooper's Hill for those appointments, the Government will hardly persuade men to enter Cooper's Hill at all. Why should men enter there and pay 150*l.* a year when they can obtain from King's College, as I believe, at least equally good instruction at a far less price, and when they see no more chance of getting an appointment at the end of their course than our own men?

7065. Then, assuming that such examinations are fairly carried out, your impression is that Cooper's Hill College will prove to be a failure?—Yes; I think so.

7066. At any rate, the objections which you have so strongly stated will, as I understand, be very considerably met by the present understanding, that there should be a fair examination at the end?—Yes, quite so.

7067. I think I understood you to say, with reference to the religious question which has been alluded to, that your prizes are open, and that there is no religious test?—All the ordinary class prizes are open to every student attending the class, but this is not the case with all the endowed prizes, some of which are more or less tied up by the terms of their foundation.

7068. Perhaps you will put in a statement of what prizes there are which are specially limited?—The whole amount of endowment for scholarships and prizes is 18,000*l.*, of which A., 2,400*l.*, were given specially for students preparing for the ministry of the

The witness withdrew.

The Rev. ALFRED BARRY, D.D., examined.

7079. (*Chairman.*) I believe you are the Principal of King's College, London?—Yes.

7080. The Commission have observed that in the original rules of the College, there was one which required attendance at the College Chapel in the morning, and which we understand, you, in the exercise of your function as Principal, with the consent of the Professors, modified?—The change has, I believe, the approval of the Professors, although this is not absolutely necessary. I have modified it as far as this, that it is said that students are "expected" to attend, unless they have stated to me conscientious grounds to the contrary. But whether they attend or not we take no notice at all. We enforce no attendance. [*See note at the end of this evidence.*]

7081. You exert your influence as the Principal of the College whenever you think it does not interfere with conscientious scruples to secure that attendance?—Yes, undoubtedly, and of course the effect of that influence will vary under different circumstances of age and character, and possibly in different departments of the College.

7082. But even a neglect of your advice in cases where there was no religious scruple would not affect the privileges of the student as respects his instruction in the College or his progress in his studies?—In no respect. To say the truth, I do not know who is there and who is not, for I make it a point of not knowing. The attendance is variable, but it is on the whole satisfactory; and I may perhaps add this, that

Church of England; B., 4,000*l.*, were given for subjects of secular study, but including "divinity"; C., 5,000*l.*, are in the same position as B., but "the Church Catechism" is added to the other subjects of examination; D., 6,600*l.*, are unconnected with religion.

7069. The Professors are all expected to be members of the Church of England, are they not?—Except those connected with the Oriental languages, or with French or German.

7070. In what sense are they expected to be members of the Church of England—have they to sign the 39 Articles?—No, they are simply asked; they have to state in the application for their original appointment that they are members of the Church of England.

7071. There is a rule in the Calendar that the students are all expected to attend the service of the Church of England. I think I understood you to say in answer to the Chairman, that it is understood that that is perfectly optional on their part?—It is perfectly optional; there is no "marking" of attendance at all.

7072. Is there any honourable understanding that they should attend?—I am afraid not. I wish there were. The Principal continually urges attendance on them, but they do not come, at any rate regularly, in as large numbers as we should wish.

7073. But it is a very material difference whether they are expected to attend and neglect doing so, or whether it is understood that it is perfectly optional?—I think the Principal will tell you when you see him, that he considers it perfectly optional, and I would rather that he should answer that question.

7074. He has power to modify the rule, has he not?—He has power to modify it.

7075. Practically when any application is made to be excused attendance, is it ever refused?—No, never.

7076. And I presume that if any change were made in that respect, ample notice would be given?—Certainly.

7077. No one who had entered the College with the understanding that upon application he would be excused from attendance, I presume, would be refused that permission on the ground of any change of principle, or any other alteration?—Certainly not.

7078. (*Chairman.*) Is there anything that you would like to add to your evidence arising out of the examination?—I think not.

the natural result is that the attention in chapel is greater than probably would be the case if compulsory attendance were enforced.

7083. Will you describe what is the extent of the religious limitations in King's College itself, besides the attendance at chapel which is now removed?—I ought to mention, in the first place, that the charter requires that all the members of the teaching staff, except the foreign language masters, should be conforming members of the Church of England.

7084. What is the nature of the declaration of conformity?—A man simply says, "I am a member of the Church of England." I forget the precise phrase that he uses.

7085. He is not required to sign any particular declaration, formulary, or profession of faith?—He signs no declaration whatever, and I may add that on one or two occasions, when I have been consulted upon the matter, I have always advised the taking of a man's statement absolutely without inquiry. I may add that we have never a lack of excellent candidates for our appointments. With regard to the students I ought to say (although probably you have already been informed of it), that there are two classes of students, namely, the Matriculated Students, who take certain courses of instruction, and who are admitted to the Associateship if they earn it, and who also have a certain privilege given them in a pecuniary way, by getting their instruction somewhat cheaper in the aggregate than they would in detail; and, on the other

J. W.  
Cunningham,  
Esq.  
—7  
20 March 1871.

Rev. A. Barry  
D.D.  
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Rev. A. Barry,  
D.D.  
20 March 1871.

hand, there are the Occasional Students who attend just what classes they please; and with regard to the occasional students there is no limitation whatsoever. They may or may not receive religious instruction. We ask no questions about them, they attend their classes, and if they do their work there, we are entirely satisfied. With regard to the Matriculated Students, in every department there is invariably one or (in one department) two lectures a week, upon religious subjects. These are given by myself or by the chaplain, and unless a student has obtained leave of absence, he is expected to attend those lectures, and to pass an examination upon them. This is the case in all the departments of the College, except in the medical department, and in that department the lectures are given only during the first year of study. The lectures are mostly Scriptural, occasionally on the Prayer-Book, and they have been, I fancy, upon Church History, although not in my time. With regard to them, we invariably accept the plea from any student, or rather from the parent or guardian of any student, of conscientious grounds of objection. We rarely have such grounds stated, excepting in the case of Roman Catholics, and occasionally, when the lectures have been upon the Prayer-Book, from Nonconformists. It has happened to us to have students who are not Christians; these have occasionally attended, but they do as they please about it. We had, I remember, a Cinghalese, and I think he is in the College at this moment—what his religion is I cannot pretend to say—but he attends neither chapel nor religious instruction. You will, therefore, of course, observe that there is no profession of faith or quasi-profession of faith required. All that is required is, that unless reason be shown to the contrary, Matriculated Students shall attend upon certain religious instruction.

7086. Upon a conscientious objection being stated, such persons would be exempted?—There would be no hesitation on the subject, nor do I imagine that there ever has been; but I can only speak of my own practice. I should say that these things rest entirely with the Principal. I have no occasion to consult the Council or Professors in the matter; I am considered to be absolute, subject to an appeal to the Council, and I act accordingly.

7087. Could you state the proportion of students who are exempt on the ground of religious scruples?—It would be difficult to state it off-hand with perfect accuracy; but if I were to put it at three per cent. it would be a high estimate.

7088. (*Professor Stokes.*) Our attention was called to-day in the course of the examination of another witness to the rule which appears in the Calendar that matriculated students are required to attend the daily service in the chapel at 10 in the morning, unless they are specially exempted by the Principal—was that left in accidentally, or was it left in with a view to exercise a sort of insensible influence?—It has always been there, and I had left it unaltered, with a view to exercise that kind of influence of which you speak; but it was put to me recently that the thing might be misconstrued, and in the next Calendar you will find that the word “expected” will be substituted for the word “required.” The line that I tried to draw was this. I will not compel, neither will I leave it to be thought a thing indifferent. I will endeavour to take the middle course of moral influence in the matter. But it was pointed out to me that under those circumstances “required” was an unfortunate word, and we have settled to alter it to “expected.” I may add that it has been my practice ever since I joined the College, nearly three years ago, to abstain from all “marking,” such as is practised at Cambridge.

7089. When the scheme for founding the College was originally put forth, was it from the first stated that it was to be in connexion with the Church of England?—Yes, emphatically. I may, perhaps, call your attention to a passage from the charter—“We do hereby will and ordain that the various branches of literature and science, and also the doctrines and duties of Christianity as the same are inculcated in the United

“Church of England and Ireland, shall be taught in the said College.”

7090. Then I understand that the whole of the funds by which the College was founded, with the single exception of the grant of land from the Government, were raised on the faith of that connexion?—Undoubtedly. You probably are quite aware that it almost immediately succeeded the founding of University College on different principles.

7091. (*Chairman.*) Are the endowments and the exhibitions which are given by the College also open to persons who are not members of the Church of England?—Yes, entirely so. There are certain prizes, such as the Leathes’ prizes and the Warneford prizes and scholarship which, by the nature of their foundations, require a certain amount of religious knowledge; and that religious knowledge may include the knowledge of the Prayer Book or the Church Catechism. With regard to the general scholarships I will call the attention of the Commission to the scholarships at page 216 of the Calendar. For those scholarships in the medical department there is what is called the divinity pass examination, and this is only dispensed with in cases where the Principal has granted exemption from religious study on conscientious grounds. In no case, however (except in the Theological Department), is there any qualification of Church membership.

7092. Will you inform the Commission what is the relation of the scientific teaching to the general education given in King’s College?—In the first place, we have two technical schools, viz., the Applied Science Department and the Medical Department, of which the former prepares especially for the Professions of engineering, architecture, and chemical manufacture; and the latter for the professions of medicine and surgery. Besides these departments, I recently introduced, with the consent of the Professors and the Council, what is called the Modern Division of the general literature and science department; and the subjects of study in that department are regarded as giving a liberal as opposed to a professional education. They are as follows:—Religious instruction, mathematics, natural philosophy, chemistry, English language and literature, French, German, and drawing. The students of this division are required to show at present an elementary knowledge of Latin, otherwise they have to attend an elementary Latin class. Perhaps in order to complete the view of our work, I may add the Classical Department, which follows the ordinary course of classical study with a somewhat large admixture of mathematical and modern subjects. In addition to this, there is the Theological Department, training for the ministry of the Church of England; and there is the School, similarly divided into the classical and the modern division, which is intended to train boys for the senior departments of the College, or for other work.

7093. The Commission would have great interest in any statements you have to make respecting the development of the modern division of the general department?—I ought to say that this division is at present a new creation, being only about a year and a half old. I started it, because I found that there was a class of students intermediate between the students of the Classical Department and the more technical students of the Applied Science Department, and I found that they were occasionally attending that technical system simply with a view to a general liberal education. Now in that technical system, the element of literature was necessarily ignored, through the pressure of scientific subjects, and I thought, therefore, that, considering the general feeling upon the subject of education at the present day, we should do right to make a “Modern” system of education which should have represented in it the great elements of language, of mathematical reasoning, of natural science, and of art (in the form of drawing), forming a system of liberal education, without any distinct reference to the subsequent



employment of the students attending it. I should say that this division is now about half as large as the original classical division, and that it shows signs of steady and satisfactory increase.

7094. (*Professor Stokes.*) Is Greek insisted on in that department?—No; not only is it not insisted upon, but we have no arrangements for it. We found it impossible. Latin at present is required, but I have just received a representation from the Professors, urging that the requirement of Latin should be discontinued. It was originally put in, not at my suggestion, but in deference to the opinion of a very valued member of the staff, and already it is found impossible, for want of time, to work it in conjunction with the large number of other subjects. I ought, perhaps, to say that in the Modern Division of the School, Latin is a subject of study for the younger boys.

7095. (*Chairman.*) We have learnt from the Secretary to the College, that in the successive stages of its development, it has had to struggle with great difficulty on account of the insufficiency of its resources, to meet the great demands, especially for the scientific teaching: I presume you would confirm that?—Undoubtedly that is the case.

7096. Have you any further statement to make on that subject, particularly in relation to the competition of colleges which receive aid from Government?—Of course I do not know precisely the evidence you have heard. Mr. Cunningham knows more of the financial difficulties than I do, but I can mention one point. The system of our College is this; the general expenses of the College are met from a quarter of the fees received, the other three quarters going directly to the teaching staff in each department. Hence it follows, that each department makes a kind of contribution, so to speak, to the general College funds. In the literary departments of the College, such as the Theological and the General Literature, that contribution is large; but in the scientific departments, the contribution is comparatively small, owing to the large expense that is involved in the way of machinery and experimental work, the payment of curators of museums and the like, so that our College is actually weighted pecuniarily by the existence of those scientific departments.

7097. (*Professor Stokes.*) How is it as regards the Modern Department?—I can hardly answer that question. The modern department entails little or no extra expense, because the Applied Science Department already exists; but where such a department existed separately, no doubt, the same thing would be true in some degree.

7098. Would the Modern Department contribute?—Yes: and, so far as it was a Literary Department, it would answer well financially.

7099. Practically, would it really contribute more than would defray its own expenses?—Yes; certainly. The department which involves the greatest expense is the medical. Our medical school, thanks to the great hospitals, which by their endowments prevent us from raising our fees, is kept up almost at a loss, and I imagine that that is the case with many of the medical schools. If our Medical Professors had no position of their own in addition to their salaries, I often think that we should get no professors at all. The expense again, of the anatomical museum, of preparations, and the like, is very great, so that the medical department contributes a very small portion to the fees of the College. The next least lucrative is the Applied Science Department. The General Literature, and the Theological Department, and the School, all contribute exceedingly well as a rule—in fact, the pecuniary difficulty, as the Secretary probably stated to you, is a thing which almost entirely results from the existence of our scientific departments.

7100. (*The Chairman.*) Supposing that other colleges had the advantage, either from private or public endowments or from a Government grant, of considerable aid to their annual resources, and especially if to those advantages were superadded that of the distribution in their favour of Government patronage,

do you think that it would be possible for King's College to compete successfully against such disadvantages?—It would compete at very great disadvantage, and if "successfully" be meant to express "prosperously," undoubtedly not.

7101. In point of public equity, therefore, taking into account the service already rendered to scientific education by King's College, you would conceive that it had at least an equal claim in any distribution of any public funds or public patronage which the Government might think fit to give to scientific instruction?—Yes, and I may add that we have also ventured to represent this in a Memorial to the Indian Department upon the subject of the New Indian College, similar to others, perhaps, which you have probably had before you.

7102. You are probably aware of what the decision of the Government has been upon the subject of the Indian College?—Yes.

7103. Are you satisfied that the decision which has been made will be sufficient in relation to the interests of King's College, London?—Undoubtedly it will not be all that we, the Memorialists, should desire, because it is clear that the Government comes into the field with the advantage of the public purse, and can pay their teaching staff very far better than we can pretend to do; the effect ought to be that they should draw the best teachers to their College by being able to remunerate them most largely. If they get the best men, their tuition ought to be the best, and if their tuition is the best, of course, they will gain the greatest amount of success. I say it ought to be so, because other than pecuniary influences come in. But, in the abstract, there is still an inequality, even after the concessions which I am pleased to see that the Government has made.

7104. Have you formed any conception of an equitable mode of administration by which King's College could be placed upon an equal ground with any special colleges which the Government may think fit to found, both as to the means of instruction and as to other public advantages that may be offered?—With regard to absolute endowment of instruction I can see no scheme that would satisfactorily work. With regard to the advantages offered, we can only, I presume, ask for that which is now to be conceded in the case of the Indian College, namely, open competition; but I should venture to deprecate the foundation of Government colleges under any circumstances, unless grave cause, from the deficiency of the present system of education, be shown.

7105. Have you ever reflected that it might be possible, if the Government were supplied by colleges, not having an immediate connexion with it, with officers for the scientific staff of India, or for any other such service, they might, in consideration of the educational advantages given in the training of such officers, make a contribution to the College as a payment for that result?—Yes, a bonus, as they call it in the Training Colleges, upon the results, might certainly be given, and that would be a non-invidious way of supplementing the resources of the College, because it would be a kind of payment according to results.

7106. And would not it be likely to operate as a salutary stimulus in the rivalry of the several colleges to make perfect all their appliances in education, and secure the utmost exertion on the part of their professorial staff?—No doubt; and though it is not a perfect arrangement, it would be, on the whole, equitable. To us, I should certainly say, that it would be of the very greatest possible value.

7107. There would obviously be on the part of the several colleges, in proportion to the emoluments so distributed; a general desire to satisfy all the wants of the Government for the production of officers of high scientific instruction and skill?—Yes, and not only a desire, but additional power. Being a poor College, we are frequently unable to do what we should desire to do for our scientific work, and I have not the smallest doubt that, if such payments were made, the Council

*Rev. A. Barry,  
D.D.*

20 March 1871.



Rev. A. Barry,  
D.D.  
20 March 1871.

would keep a considerable portion of the money so gained for the improvement of the scientific arrangements, and machinery of the College, while at the same time it remunerated the staff who had been engaged in the work.

7108. Even if the grants for such results were connected with conditions as to their application affecting the efficiency of the colleges in those respects, there would probably be no difficulty on the part of the colleges in consenting to those conditions?—No difficulty in consenting to any reasonable conditions. One might easily imagine impracticable conditions; but such conditions as would be likely to be imposed, no doubt, we could meet and should gladly meet.

7109. (*Dr. Sharpey.*) Originally, if I mistake not, in the constitution of King's College there were proprietors and donors?—Yes.

7110. Does that constitution still exist?—Theoretically. It is provided for in the charter. A donor, of course, from the nature of the case, reserves no rights to himself, except such as, perhaps, the College might have given him for his life. But a proprietor is still a proprietor in the College, and ought, theoretically, to receive, although he never does receive it, a dividend upon his shares. I should add that from the results of an inspection of the charter which I was obliged recently to make, I found that the powers of proprietors of King's College are very limited.

7111. Do they elect the Governors or the Council?—They elect the Council; but the lists must be submitted to and tested by those who are called the Life Governors of the institution, certain official persons, so that their franchise is exercised within narrow limits.

7112. With reference to the operation of Government institutions for the education of Government officers, I presume you would consider that the competition of independent institutions would have a salutary effect upon the Government institutions?—Yes; it must have a salutary effect upon the Government institutions. Both theory and experience appear to me to prove this without a shadow of a doubt.

7113. (*Chairman.*) Is there anything which you would like to add to the evidence arising out of your examination?—The only point which I should like to call the attention of the Commission to is the comparison between what I may call the educational effects, so far as I can trace them, of the various departments of the College. Perhaps you are aware that I am the only person in the College who is connected with all the departments, and, therefore, have had an opportunity of instituting that comparison; and I suppose I may say without invidiousness, that in regard of general culture (cultivating the powers of thought, and still more the powers of expression), I was struck with the necessity of the admixture of some literary element into the purely scientific teaching of the Applied Science Department. Student for student I am bound to say it appeared to me that the students of the General Literature Department showed the effects of such culture more than those of the Applied Science Department, and it was for that reason that I endeavoured to institute this "Modern" Department. The results of the experiment I am not yet able to give, but I am very profoundly convinced that the merely scientific training which we were obliged to give in the Applied Science Department did not work educationally as well as we could wish. Perhaps I might be allowed to say that I observed somewhat the same thing in my former position at Cheltenham, where we had two co-ordinate departments, the classical and what was there called the modern department; the latter of which, inclining towards Woolwich and civil engineering, was to some degree technical, but, at any rate, was somewhat deficient in the literary element. I have twice had an opportunity of expressing the opinion which I then formed, and which I still retain, viz., that, educationally, the great predominance of what is commonly called the scientific element was not wholly favourable to the mental development of the student or a boy. I then

had to speak with a certain amount of reserve, because I knew that the classical system has the advantage of long custom, and the consequence is that it secures the best schoolmasters, and is more fully elaborated in the school system. But in King's College that has not been so. Our Professors in the Applied Science Department are quite as good as in any other of the departments, and, therefore, we have not that difficulty of comparison. The comparison, therefore, taking it for what it is worth, is free from that disturbing influence which affects it in most public schools.

7114. Applying what you say to the matriculation examination of the two English Universities of Oxford and Cambridge, what inference would you draw as to the nature of the examination which you would require, supposing you were willing to admit a student to a purely scientific course in those universities?—You are referring to a Matriculation examination, supposing it to be instituted, knowing of course that it does not exist now in our older Universities, except where collegiate bodies supply what the University ought to do. I should be inclined to think that we ought to have those four elements which I have already referred to—first, some knowledge of language; next, some elementary mathematical knowledge; thirdly, some knowledge of physical science (perhaps, according to the scheme which I remember the British Association once drew out as a scheme of elementary instruction for schools); and, lastly, I should like some weight given to art, whether in music or drawing. I may add that I should not greatly care whether language were studied in the classical languages, or whether it were thoroughly studied in the modern languages.

7115. But with a matriculation examination of that kind, involving a definite amount of literary culture, you would open the studies and emoluments of our Universities to purely scientific culture?—Most certainly. I should parallel the case with the preliminary examination in the medical profession, which aims at securing the elements of a liberal education before the definite professional training begins. Speaking from my experience, I have seen already the very salutary effect of such examination upon the medical students of London.

7116. From your experience in grammar schools, of which you have been for so many years a chief, is it a too sanguine expectation that, in the course of years, the public schools of the country might become the means of giving such preliminary training as would enable students intending to devote themselves in the Universities to science to pass the preliminary examination in literature, which has been described?—There can be no question that it ought to be done.

7117. Is King's College put to any charge on account of the instruction given in the evening classes by its several professors?—The Evening Class Department, so called, is a reproduction of all the departments of the College, excepting the Medical and Theological Departments. The lectures given, as you will see by the Calendar, are both in literary subjects, such as in the General Literature Department, and scientific subjects, as in the Applied Science Department, and in fact in most subjects of ordinary education. In that department the fees are exceedingly low. The original intention was to help those who had small means, and who were engaged in work in offices, shops, and the like, during the daytime. The consequence of this is, that this Evening Class Department contributes very little to the general resources of the College; that in fact we are put to a great deal of expense, especially in the way of gas-lighting; and that it entails a rather heavy burden of ill-remunerated work upon the staff. But we are carrying the thing on, believing that it supplies an educational necessity of London, and being encouraged in that belief from the circumstance that something like 500 or 600 students attend this department.



7118. (*Mr. Samuelson.*) Do you think it is a feeder at all to your other departments?—Hardly at all; in fact I think occasionally it acts against them. Sometimes men are shortsighted enough, in order to save money, to be satisfied with the more elementary or less detailed instruction in the evening classes, when they might perfectly well afford to pay for the morning classes; and so much is that the case that my attention has been drawn to it to see whether any limitation could be devised to discourage such a state of things. On the other hand, occasionally, a young man will find out his capabilities in this department, and then, throwing up his occupation, will come to the morning classes; but such cases are exceedingly rare.

7119. Those who attend the classes are generally young men who are employed in offices, shops, and work of various kinds?—Yes; a very large proportion of them, and in that case, of course, I do not at all object to their using the department; but occasionally I find men attending there who are not so engaged, who might easily attend the morning classes, and who, I venture to think, could probably afford to pay for them.

7120. Have you found that Students of the School of Mines come to you for instruction in mathematics, or in any other subject which is not taught in the School of Mines?—I am not aware of such instances; but I cannot say that they do not exist. On the other hand, I have known instances of students, who would have come to us, going off to the School of Mines, although quite able to afford our fees, because they could get their instruction in certain subjects more cheaply there.

7121. Do you think that it was because they could get it more cheaply or because they had an impression that the instruction was more special in the School of Mines?—I think I am right in saying that it was upon the point of economy. There were two instances in which I know this; as to the others, I can only conjecture.

7122. Would it assist you, if arrangements were made by the Science and Art Department, by which scholarships at King's College were established with a payment somewhat approaching to what is excused in the case of the School of Mines, say from 25*l.* to 50*l.* a-year?—I should think it would be a very great help to us. Our payment is rather heavy in the Applied Science Department.

7123. The case as it stands at present is this, that the scholarships would be given to the students, but they would have to pay your fees if they came to you, whereas, if they entered the School of Mines they might obtain a free admission there by competition, so that to that extent you would be at a disadvantage?—Certainly. But still our want of scholarships is such that, although we can very ill-afford it, the professors have just resolved to establish scholarships of that kind in the Applied Science Department.

7124. Would it not be possible to make King's College School a feeder to a greater extent than it now is to the College, by changing your arrangements?—The process that has been contemplated is, I believe, the one that exists at University College, that is to say, imposing a limitation of age in the school, except under

special circumstances; and in that way, of course, when a boy got to a certain age, he would be required to come into the College, unless there were special reasons to the contrary. That has been proposed, and it is just possible, with the increasing number of our School, that some such regulation may be made. But at present we find that there are certain parents who prefer that their sons, even up to the age of 18, should be under the stricter discipline of the School rather than under the freer system of the College; and we feel certain difficulty in obliging those boys to leave the School under present circumstances where they are doing well. The effect, therefore, is that at present the School overlaps the College; and it is a subject of consideration with us as to how far we could manage, without injuring the School, to make it feed the College more completely than it does.

7125. Would it not be possible that you might give some compensation to the School, by requiring students who come up ill-prepared for the College, to attend one or two sessions at the School before admitting them to the College?—Probably that would be a dangerous enactment. The effect would be that you would introduce boys into the School overgrown for the classes in which they would be placed, and you would do more harm than you would do good to the School. I should very much prefer rejecting those students altogether, and leaving them to prepare themselves privately for the College.

7126. You would find it difficult, would you not, to enforce any stringent matriculation examination, unless a similar examination were required by the other colleges in London?—I think we should find it difficult, but I am a little at issue with some of my colleagues there, being inclined to fancy that we might do more in that respect than we have ventured to do as yet. We have, theoretically, a matriculation examination, and we reserve to ourselves the power of rejecting students; and I am inclined to think that any college that did this stringently, if it were done with anything like judgment, would probably tend to raise the future standard, and so compensate themselves for the students that they rejected.

7127. And it would attract students by raising its own reputation?—Just so. I ought to say that we do reject students, although not so much as I would wish to do. In our Theological Department we reject most stringently, but in the other departments we are considerably looser.

7128. (*Chairman.*) Does anything else occur to you that you would wish to mention to the Commission?—Nothing that I am aware of.

*Note on the Answer to Question No. 7080.*

I should wish this expression of satisfaction to be considered as given with some qualification. I am unhesitatingly of opinion that it is better on the whole to dispense with any enforcement of attendance, even if such enforcement were managed with consideration and liberality. But it is certain that there are many who would be helped by the existence of a rule (on this as on other subjects) against carelessness, unpunctuality, and irregularity; and who would, when brought to chapel by its aid, thoroughly enter into the service, and be glad to be there. These suffer by the change; and this is especially likely to be the case where, as at King's College, attendance at lectures is enforced, and, therefore, the exceptional absence of all regulations as to chapel is the more notable.

The witness withdrew.

Adjourned to to-morrow at half-past eleven o'clock.

*Rev. A. Barry,*  
*D.D.*

20 March 1871.



6, Old Palace Yard, Westminster, Tuesday, 21st March 1871.

PRESENT :

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, BART., IN THE CHAIR.

BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

JOHN ROBSON, Esq., B.A., examined.

J. Robson,  
Esq., B.A.

21 March 1871.

7129. (*Chairman.*) You are Secretary, are you not, of University College, London?—Yes.

7130. And are likewise, I believe, Clerk of Convocation of the University of London?—Yes.

7131. Of course your office has made you familiar with the history and the constitution and the present condition of the finances of University College?—Yes.

7132. Will you be good enough to state any circumstances to us which you consider material, first as to the history of the College?—I have in my hand a statement, which has been carefully prepared, showing the very large sums of money which have been raised by the friends of education for the purpose of establishing and maintaining the College, and I will read a few of the principal items. There was the sum of 30,000*l.* spent in purchasing the land upon which the College is erected, and 125,000*l.* for buildings and furniture. There was very nearly 4,500*l.* expended in providing a library in the first instance; there have been expended on the anatomical and materia medica museums upwards of 6,000*l.*; on the chemical, physical, and physiological museums more than 4,000*l.*; on the Birkbeck laboratory of chemistry upwards of 3,000*l.*; and on the museum of comparative anatomy and zoology more than 600*l.* The whole of this money has been provided from the original share capital, and from donations and legacies, no part whatever of it having been derived from any parliamentary grant. The College has never received, I believe, a single farthing of public money since it was first instituted in 1828; and although, in the first instance, the College was nominally a joint stock company, and the original deed of settlement provided for a dividend of four per cent. on the share capital, yet no dividend has in fact ever been paid, the expenses of the College having from the very first largely exceeded the receipts from that portion of the fees paid by students applicable to the payment of them; so that the supporters of the College, the proprietors as they were then called, soon abandoned all idea of receiving any dividend whatever. When the Government of the day proposed to institute the University of London—I have no doubt that all the Commissioners are aware that that was the original title of the institution which I am now representing—but when the Government in 1837 determined to found the present University of London, proposals were made to the Council of the College that the College, or the University, as it was then called, should give up its title in favour of the institution then proposed to be founded, and should take, instead of it, the title of University College, London; these proposals the Council, after much consideration, recommended the proprietors to accept; and at a special meeting of the proprietors, this recommendation was adopted. This was done without any pecuniary consideration; in fact, one may say without any consideration or advantage of any kind whatever. Of course, the original title of University was unauthorised; it was a title which the founders of the institution had assumed, and did not confer the privileges of a University, that is to say, the power of granting degrees. But it is important to remember that, in March 1835, the House of Commons, by a large majority—246 to 136—adopted an address to the King, praying him to grant a charter of incorporation to “the University of London,” which would have

enabled it to grant degrees; and, consequently, that what the institution was asked to surrender in favour of the University founded in 1837, was not merely its designation, but the position which it had acquired through that vote of the House of Commons, and the importance of which had been distinctly recognized by successive Governments. When I say, however, that the measures of the Government in 1837 were unattended with any compensation for the sacrifice thus submitted to by University College, I must qualify that statement by admitting that the new institution—the present “University of London”—did enable the students of the College to obtain academical degrees with greater facility than they otherwise could have done; and, of course, as the degrees of that University were and are conferred without any reference to religious tests, many students of the College who were precluded by theological considerations from taking degrees at the old Universities, thus gained a not unimportant advantage; and this again was an indirect benefit to the College: but so far as the State was concerned, the concession asked for from the College was made without any pecuniary compensation. To revert from this digression; in carrying on the institution it was soon found that the sanguine expectations of its founders were not realised, and that the expenditure of the College was considerably in excess of the receipts. I have a general summary here from which it appears that since the opening of the College up to the year 1869, 18,393*l.* beyond the College share of the fees has been expended on maintaining the College; and of course that large sum was provided by trenching on the capital of the College. Considerable sums of money have from time to time been bequeathed to the College for general purposes, and the Council have considered that they were justified in making use of portions at all events of those bequests for the purpose of carrying on the College; but this fact is sufficient to show the great difficulties which the College has had in maintaining itself. In addition to the above-mentioned sum, rather more than 10,000*l.* has been expended in payments to professors in augmentation of their share of the fees, in retiring pensions, and in allowances of various kinds, and which also has been wholly provided out of bequests.

7133. Will you state to the Commission what was the nature of the charter of incorporation, and the circumstances under which the recent Act of Parliament was passed?—The charter of incorporation was granted at the time that the University of London was established. It was one of the conditions of the agreement between the College and the Government that when our original title was given up, the institution should be incorporated by a Royal charter under the title of University College, London. No mention whatever was made in the charter of that provision of the deed of settlement which related to the payment of a dividend; and although the proprietary rights of the shareholders were not formally abandoned, and in fact provision was made for the transmission of their shares, yet all reference to any pecuniary advantage to be derived from the possession of those shares was carefully left out of the charter. We went on under that charter for 32 years, until, in the year 1869, some legal members of our Council began to feel doubts



whether the charter had so effectually extinguished the proprietary rights of the shareholders as was desired. It seems to have been taken for granted at the time when the charter was drawn up that the omission of any reference to dividends would be sufficient to extinguish all legal claim to them; but the gentlemen to whom I allude thought that it was extremely doubtful whether that assumption was well founded; and, as the number of proprietors was rapidly diminishing, having sunk from about 1,500 to, in 1869, little over 500, it was considered by no means improbable that at last the management and control of the College might fall into the hands of a very small number of persons, who might wish to avail themselves of their power for their own pecuniary advantage by exercising their proprietary rights under the charter, which gave them the power of closing the College and of putting an end to it entirely. It was felt that that was a most unsatisfactory state of things, and the Council at once proceeded to take measures to place the College on a more secure basis, by appointing a Committee to examine into the question and to decide what would be the best course. Finally, it was determined to apply for a private Act of Parliament, which should do effectually what it had been intended to do by the charter. The bill was introduced into the House of Lords in the early part of 1869. It had previously been submitted to a general meeting of the members, at which it was unanimously approved. There was not a single dissident in the meeting. It passed also through both Houses of Parliament without opposition. The cost of it, notwithstanding, was very considerable, amounting to nearly 900*l.*, which the College cheerfully paid. The main object of the Act was, as I have said, to extinguish all proprietary rights. The ninth section of the Act says:—"The present and future members of the College, whether governors, fellows, or life governors, shall not be entitled to any share or shares in the possessions, property, capital, or income of the College, or any right to participation in the receipts or profits thereof, or any proprietary or individual or transferable or transmissible estate, right, or interest whatsoever (whether actual, contingent, or otherwise) in or to such possessions, property, or capital, income, receipts, or profits, or any part thereof, or any preferential or special right of presenting or nominating students; and the said possessions, property, and capital, income, receipts, and profits (subject as to the hospital and as to endowments or other property impressed with any trusts or special purposes to the due performance and observance thereof) shall belong wholly to the College in its corporate character, and shall be wholly appropriated to and available for the promotion of the objects for which the College is hereby incorporated." So that the corporation actually spent a large sum of money for the express purpose of extinguishing all the individual and proprietary rights of its members. At the same time, we took the opportunity to enlarge our powers in several directions. We have now the power, which we had not before, to instruct ladies as well as men in the College, and also to give instruction in the fine arts; so that several restrictions which prevented the extension of the operations of the College have been removed by this Act.

7134. Having regard to the excess of expenditure which has been provided out of capital for various purposes already enumerated, will you inform the Commission whether the College has enjoyed sufficient resources for providing suitable and sufficient laboratories, apparatus, and assistance for the practical Departments of Experimental Science?—Its resources for these purposes have been quite inadequate. We have of course provided laboratories, and have recently spent some money in extending and improving them; but in order to provide for all the requirements of the professors they would need to be much larger than they now are, and to be better supplied with fittings and apparatus. We have the Birkbeck laboratory,

which affords accommodation for, I think, about 30 students in analytical chemistry; and there are times when considerable difficulty is experienced in providing sufficient accommodation in the laboratory for the whole number of students. That was felt some two years ago when a number of students were preparing for the service of the Indian Telegraph Department. I see there were as many as 20 of these students in the year 1866-67; and as practical chemistry was a very important part of their preparation, they interfered, to a certain extent, with the other students, and the professor had to make special arrangements, involving a considerable addition to his own labour and to that of his assistants, which might no doubt have been prevented had the laboratory been considerably larger than it is. And even this laboratory was not provided wholly out of the funds of the College. It is called the Birkbeck laboratory, because the subscriptions raised by a number of mechanics' institutions in various parts of the country in honour of the founder of the first of such institutions were, after some negotiation with the Council of the College, handed over to the College, to be employed in helping to build this laboratory, which, as I have stated, cost upwards of 3,000*l.* The amount of these subscriptions was under 1,000*l.* With respect to the laboratory of physics, I may be allowed to remark that the application of exact measurements to various branches of science, such as electricity, is becoming a very important branch of instruction in science. When our present Professor of Physics, Mr. G. Carey Foster, was elected, he pointed out to the Council the importance of having the means of giving practical instruction in the various subjects which he had to teach, and the Council complied with his suggestions as far as they had the means of doing so. Those means were so limited that they were sufficient merely to fit up one of the ordinary rooms as a physical laboratory, and to add a considerable quantity of modern apparatus to the stock which we previously had. Mr. Foster went over that stock very carefully, and drew up a long catalogue of the apparatus which he considered indispensable for carrying on his work, and the Council gave him what he said was absolutely necessary at once, but were compelled to withhold a large portion of what he wanted, and which he said would be extremely useful. That laboratory has been of great service, considering its limited appliances, and especially at the time when the telegraph students were at the College. But the number of students usually working in it is not very great, and that may, perhaps, be partly owing to another fact, namely, that we have not the means of providing the professors with sufficiently qualified assistants. Professor Foster has an assistant, who is a very useful man, but he is not a man of science, and hence the whole of the work of instructing the students, who have to be taught individually in the Laboratory, has to be done by the Professor, who has consequently to devote a large amount of time to a small number of students.

7135. Has the limited condition of your resources also caused difficulties in securing and retaining the services of competent professors?—We have felt those difficulties repeatedly, and we are in fact doing so at this very moment. The incomes of our professors, with one or two exceptions, are wholly derived from their share of the fees paid by the students. The rules about the distribution of fees between the College and the Professors are as follows: The 21st part of the fees paid in a session for the class or classes of any professor is first deducted and retained by the College. When after such deduction the fees so paid do not exceed 125*l.*, nine-tenths of the amount are paid to the professor; when they are above that sum, but not more than 300*l.*, the professor receives 100*l.*, and one half the remainder: when they are above 300*l.* two-thirds of the amount are paid to the professor. The practical result of these rules is, that in the large classes the College receives one third of the gross fees; and it appears from the last Report of the

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Esq., B.A.*

21 March 1871.



J. Robson,  
Esq., B.A.

21 March 1871.

Council that the College share of the College fees for the session 1869-70, amounted to 2,594*l.* 0*s.* 7*d.*; and that of School fees, to 2,462*l.* 17*s.* 11*d.*, making together the sum of 5,056*l.* 18*s.* 6*d.*; but that was not sufficient to defray the ordinary establishment expenses, which, in the appendix to the same Report, are stated to have been 5,828*l.* 14*s.* 1*d.* The large deductions from the fees which the College is obliged to make in order to provide for the current expenses of the institution, have a two-fold injurious effect: they materially diminish the remuneration of the professors, and so far tend to deprive the College of the services of able men; and, by rendering it necessary to charge fees higher than might otherwise be requisite, they must have the indirect effect of keeping down the number of our students. The result is, that our professors as a rule are very inadequately paid. The amount received by the professors varies greatly. Those who have large classes may receive as much as 500*l.* a year, but there are very few indeed whose share of the fees amounts to so large a sum. The great majority of the professors receive much less than that. The most numerous class, and that which yields the best return in a pecuniary sense, is the class of chemistry. This class, however, is attended with heavy expenses, and our arrangement with the Professor is such that he has to defray a large part of the expenses of the class. He makes his own arrangements with his various assistants; he provides the materials and some parts of the apparatus. In consequence of the peculiarity of this class, however, the arrangement made between him and the Council is somewhat different from the ordinary one. In the case of the practical class, and in that of the students in the laboratory, the College deducts not one third of the fees, but only one sixth. Speaking generally, I may say that the stipends of professors range from 50*l.* up to 600*l.* a year at the outside, but the average is not more than 100*l.* a year.

7136. Have any obstacles arisen in the development of the scientific teaching from the competition of institutions which receive partial grants of public money, or are wholly supported by the State?—There have been one or two very striking instances of that evil within the last few years, able professors having being drawn away from us by opportunities of obtaining better remunerated posts. I may mention, as, perhaps, the first in chronological order that I am acquainted with, the fact that Professor Ramsay, who was our Professor of Geology, left us to go to the School of Mines. Then we had Professor Jenkin, whose great success as a teacher was shown by his raising the class of civil engineering from zero to upwards of 30 in the first year of his professorship; but the very next year, being offered the Professorship of Civil Engineering in the University of Edinburgh, which I understand is partly endowed out of a parliamentary grant, he resigned his post in University College, to the great detriment of the class. Professor Hirst, again, who was our Professor of Pure Mathematics, resigned his chair, partly, it is true, on account of finding that the work was more than he could sustain, and went to the University of London, accepting the office of Assistant Registrar, in which he obtains better remuneration than he was able to secure as professor of mathematics at the College. Apart from pure science, we have lost Professor Seeley, our distinguished Professor of Latin, who accepted the Regius Professorship of Modern History in the University of Cambridge; and only last year we lost Dr. Michael Foster, who was our Professor of Practical Physiology, a most able man, who had developed the teaching of practical physiology to a degree which it had never before reached in the College, and had largely increased the number of the students of that branch of science. He left us to accept the Prælectorship of Practical Physiology at Trinity College, Cambridge.

7137. Those last two instances, however, are cases in which ancient endowments have been the means

of attracting the services of able professors rather than grants of public money?—That is so, certainly.

7138. Have any means occurred to you by which the inequality of advantage of which you complain might be in any degree remedied to the benefit of University College?—I have some hesitation in answering that question, because it has never come formally before the Council, whose representative I must regard myself on this occasion to be, so that I am not here to express my own individual opinions. The question has been discussed several times in the Senate or body of Professors, but the Council hitherto have never discussed it in a formal manner. The only occasion within my knowledge in which the Council have taken any corporate action as to the competition of Government institutions with the College has been quite recently with reference to the proposed Engineering College for the Indian service. On that subject they joined the Senate in a Memorial to the Duke of Argyll, and appointed a deputation to present it to His Grace; but even in that instance the Senate was the originating body. I speak with some amount of hesitation and reserve, but I believe that the general feeling in the Council, at all events until very recently, was that if they could maintain the institution without making any appeal to the Government or to Parliament, they would very much prefer doing so. I think it may be truly said that every effort has been tried to accomplish that end. The financial statement which I have read shows that the Council have gone on from the first with a determination to carry on the institution without appealing to the public, if possible; and probably if it had not been for the recent very great extension of scientific teaching in every department all over the country, they might have continued to pursue the same policy; but it is quite clear, I think, that our means and appliances, although they might have been sufficient 20 or 30 years ago, are not sufficient now; and undoubtedly the resources of the institution have not increased of late. Large sums of money were bequeathed by benefactors in the earlier part of the history of the College; but for the last 10 years scarcely anything has been received in that way. Large bequests have within that period been made to the hospital, but no part of them can be applied to the purposes of the College.

7139. Seeing that the resources of the College are described by you as not sufficient for the adequate payment of competent professors, nor for the provision of sufficiently extensive laboratories, adequate apparatus, and a sufficient number of assistants, did you receive any payment from the Government for the training of the 20 or 30 assistants for the Telegraphic Department of India beyond the payment of the ordinary fees?—Not a farthing.

7140. So that, in fact, the College must have been at some expense beyond the fees paid by those students, and still was unable adequately to remunerate its professors?—Quite so.

7141. Would you consider it equitable that in any case of that kind in which you were distinctly training persons for the public service, you should receive from the Government some bonus for the faithful and efficient discharge of that duty?—That would undoubtedly seem to be a fair thing to do. There is no doubt that the College was established by a very large expenditure of private funds. We estimate the whole amount expended at something like 300,000*l.*, and no pecuniary return has ever been made to those who provided that money. The recent Act, to which I have already referred, effectually precludes the possibility of any future personal advantage being derived from the institution by the members of the corporation, so that the whole of that large capital has been absolutely sunk in accomplishing what may be fairly regarded as a national service, because its sole object is to promote education.

7142. But apart from the general national service of promoting public education, have there been any



other instances of specific service rendered to the Government in the training of public officers?—Some years before I was Secretary of the College, a large number of excise officers were for several years sent by the Inland Revenue Department to be trained in the laboratory of analytical chemistry. I do not know whether they were charged the ordinary fees, or whether any reduction was made in them, but I believe the former was the case. There is one additional fact which I should like to mention about the resources of the College, showing that they are inadequate. We have within the last few years received very liberal sums of money from members of the Council and other members of the College to supplement deficiencies. For instance, when we found it necessary to enlarge the buildings for the school attached to the College, almost the whole sum required was raised by such contributions: about 5,000*l.* was contributed in that way; and now again, when we are building the Slade School of Fine Arts, it has been found that the money which was very liberally given for the purpose by Mr. Slade's executors was insufficient; upon which two members of the College, who had each given 1000*l.* towards the new school buildings, came forward again to make up the deficiency, one of them giving 600*l.* the other 500*l.* This is a striking proof of the fact that we still have to appeal to the liberality of our wealthier members to help us out of our pecuniary difficulties.

7143. (*Dr. Sharpey.*) Does the revenue derived from the School aid in supporting the expenses of the College?—Last year the balance of school fees, after paying all the masters employed in it, was nearly 2,500*l.*, and this sum was applied to defray the general expenses of the whole institution, including the collegiate portion; but, of course, a considerable part, if not nearly the whole, of this balance was expended on, or was properly chargeable to, the School itself.

7144. (*Mr. Samuelson.*) What classes for science have you in the school?—There is a class of chemistry, both theoretical and practical, and also a class of physics, which is to a certain extent practical, that is to say, the teacher has apparatus, with which he performs the ordinary experiments in the elementary portions of the subject. Of course you would include mathematics in the term science; and in that department we have some most able teachers, who carry the mathematical instruction of the pupils to a high point, very much higher, indeed, than is ordinarily the case in schools. From the first institution of the School the system of instruction adopted in it was widely different from that which had hitherto prevailed in public schools of all kinds. Only a reasonable amount of time was given to the teaching of classics, and an equal share of attention was given to the teaching of mathematics and the modern languages; and that course has been uniformly pursued up to the present time.

7145. You have no division into what is called a classical and a modern department?—Not formally, but our prospectus distinctly states that any parent has a large range of choice as to what his son shall be taught. Many parents exercise that power, which, however, is subject to the veto of the Head Master, who very rarely has to exercise it; and they determine into which classes their children shall go. The consequence is that there is a considerable proportion of pupils who do not learn even Latin, and a very much larger number who never learn Greek. In fact a boy is not allowed to learn Greek until he has been through a certain number of other classes, in which he is instructed in subjects more indispensable for boys, most of whom are destined to enter into active life at an early age.

7146. Is there any specified age, or any usual age, at which boys begin to receive instruction in science?—I think there is. I do not know whether it is their age so much as the position which they have taken in the school, which determines this matter. They have to go through certain classes and to attain a certain

standing before they are allowed to join the higher classes; but of course the teaching of arithmetic, for example, is commenced at once. Even in what is called our lower school, into which we admit boys at the age of seven, the principles of arithmetic are taught; and I may say that the teaching of arithmetic has always received a large amount of attention in University College School, and has been conducted on strict principles of demonstration. Professor De Morgan, whose recent death we are now lamenting, was, as the Commissioners are no doubt aware, for upwards of 30 years our Professor of Mathematics; and his success as a teacher was owing, I believe, to the immense importance which he attached to proving the fundamental parts of every branch of mathematics, including arithmetic, in the most thorough manner. His work on arithmetic is a notable example of this method, and it was used for some years in the School. It was found to be a little too difficult to be put into the younger boys' hands, but all the masters were supposed to teach on the principles of that book.

7147. As regards chemistry and physics, what is the age and what classes are looked upon as being preliminary to the teaching in those subjects?—Arithmetic, algebra, and geometry are regarded as the bases of exact scientific study, and as affording that mental training without which the more complex branches of science cannot be successfully studied. When boys have reached the fourth or the fifth class—I am not sure which—in those subjects, they are allowed to begin the study of chemistry, and of physics, which are taught to a considerable extent on mathematical principles, and not merely by popular experiments.

7148. What is the practical result of that as regards the average age of the boys at which they begin to be taught natural science?—That most of the boys are then between 14 and 15 years of age.

7149. Is it the case that many boys pass from the School to the College?—Yes, that is the case with a considerable number, and the number is increasing, I think, from year to year. This is attributable in part, no doubt, to the very large increase of late years in the absolute number of boys educated in the School: there are 500 now, and the number has rapidly risen from 300 to 500; but, apart from this, the connexion between the College and the School has recently become much closer than it used to be. The instruction in the higher branches of knowledge has certainly improved in the School, and in that way a larger number of pupils are qualified to enter the College classes when they leave the School; and of these a high proportion almost invariably, year after year, distinguish themselves in the College class examinations. The paper I have here contains a long list of former pupils of the School who have obtained such distinctions. The list relates to the last College session, and it consists of upwards of half a page of close print, giving the particulars of the distinctions obtained by the pupils who had left the school only the previous session. This is followed by an account of the degrees and other academical distinctions gained in the University of London and elsewhere by students of our College, and among these many former pupils of the School are, as usual, to be found. I think that it may truly be said that University College School has always produced an unusual number of good mathematicians: they have gone from the School into the College and carried off many of the distinctions there, and then they have proceeded to the University, and often to Cambridge, and have there obtained the highest distinctions. We can reckon something like six or seven senior wranglers who were formerly pupils in the School. I may name Mr. Routh as one of them.

7150. Can you show a similar result as regards Physical Science?—Until recently there have not been equally numerous opportunities for obtaining similar

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Esq., B.A.*

21 March 1871.



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Esq., B.A.*

21 March 1871.

academical distinctions in physical science as in pure mathematics; but allowing for that difference, it is, I believe, the fact, that our school has sent out quite as great a number of pupils who have since become eminent in the former. I may name, by way of example, Dr. Michael Foster, Professor Stanley Jevons, Professor G. C. Foster, and Professor Guthrie, of the Royal School of Mines.

7151. (*Professor Huxley.*) With regard to chemical and physical teaching, is there a laboratory attached to the School for the use of the boys only?—There is such a chemical laboratory, but not a physical laboratory.

7152. Is it considered desirable that there should be a physical laboratory for the boys?—I have not heard the gentleman who teaches that subject in the School express any opinion on that point. He sent in to the Committee of Management a little while ago a long list of his requirements for apparatus, but I did not understand that he contemplated it being used by the boys themselves.

7153. Then at present the instruction in physics for the boys is simply lecture teaching?—It is simply lecture teaching, illustrated, of course, by experiments.

The witness withdrew.

Dr. ALEXANDER WILLIAM WILLIAMSON, F.R.S., further examined.

7159. (*Chairman.*) The Commission have received from you evidence on a previous occasion as to the general theoretic relations of the instruction in science in University College. They are now desirous to obtain any suggestions which you have to make on the organisation of that College, and its resources in relation to the development of scientific teaching. Do you find any difficulties in respect to your own chair of chemistry, either as regards the extent of the laboratories, or the apparatus, or the resources applicable to scientific research or experiment, upon which you can make suggestions tending to their removal?—I have certainly found that the absence of supplies of materials and apparatus which exist at some of the other institutions has been in my chemical work a disadvantage of some gravity, and the same thing applies also to the absence of provisions for assistance; in fact, the assistants in the chemical department are only provided out of the professor's share of the fees, and that does necessarily impose a limitation on their number, on the residue left of the fees to the professor, which I think is certainly injurious to the efficiency of my work.

7160. What is the proportion of the professors' fees which is appropriated to the general purposes of the College?—The common rule for the larger classes is that the College takes somewhat more than one third. They first take one shilling off every guinea, and one third of the remainder, but in some of my classes an allowance is made, that is to say, a small proportion is deducted by the College in consideration of my having unusual expenses in them. For instance, in the laboratory, which is called the class of analytical chemistry, the College deducts one fifth, instead of deducting one third from the fees, and then leaves me to pay for the expenses of the remainder.

7161. Your own chair and the classes attached to it are amongst the most remunerative in the College, are they not?—I fancy they must be among the most remunerative. I do not know the exact amount received by my colleagues, but from a general outline of the number of students attending them, I have reason to believe that that must be so. In fact, I hold two chairs, the chair of analytical or practical chemistry, and of chemistry, which were formerly held by two distinct professors. I held one of them originally, whilst Mr. Graham was in the College, and then by taking double work, I get something like double pay.

7162. Yet owing to the mode of remuneration,

7154. Did the Council grant all the apparatus that he wanted?—Yes; the whole of it.

7155. Then the teaching of physical science to the boys is not limited in any way by the want of funds, or the like?—I think it would be limited in this way, that in order to have a physical laboratory we should evidently want a suitable room, and at present I do not know of any room in the building which could be appropriated to that purpose. Were the College buildings extended, it is probable that a physical laboratory for the School would be provided; but here, I need hardly say, we are stopped by want of funds.

7156. (*Dr. Sharpey.*) Is there still a class of economic science in the School?—Yes; it is taught by one of the masters, Mr. Hawkes.

7157. It was begun by Mr. Shields, was it not?—Yes.

7158. And it was very successful in his time, I believe?—Yes; Mr. Shields was an admirable teacher, and his retirement, owing to ill-health, was greatly regretted. Dr. W. B. Hodgson taught the class gratuitously for a considerable time with much success; and since then it has been under Mr. Hawkes, who has as many as 40 or 50 boys in the class.

its extent must be liable to considerable fluctuation and uncertainty?—Yes.

7163. There is also necessarily a tendency on the part of the governing authorities in the College to raise the amount of fees paid by students to the maximum, and so to diminish the number of students?—I think that there is a very serious disadvantage in the fact that the fees constitute the only source of remuneration, and that it does tend to induce the College Professors themselves to raise the fees to higher amounts than what would be desirable. On the other hand, I might be misunderstood if I were not to add that I believe that in our College that tendency is very much resisted. I think the Professors are all exceedingly anxious and the Council also to keep down the fees as much as possible in the interests of education.

7164. What number of assistants in the practical classes of your chair has the College been able to afford you?—The assistants are selected and paid by myself. Two regular assistants I always have besides an attendant for cleaning and washing things, but besides those I always have the aid of several other gentlemen to a more limited extent; for instance, senior students, who without remuneration give me aid in any particular class for a moderate time. I have had occasion frequently, in fact constantly, to employ senior students as assistants in that way.

7165. What would be the effect of a fair amount of endowment connected with your chair upon your own facilities for giving instruction and the leisure you might have for experimental research?—The first thing I should wish to do, if I had had the command of more money for the purpose, would be to get better illustrations for my lectures and better apparatus for the laboratory. I should also use available money for apparatus and materials, and for assistants in original research, and that is the bigger item of the two. There is more need of more funds for that than for the other; in fact I consider that the working out of original research is really the higher part of the duties of the professor, and as long as one is in conditions unfavourable for that, one has really not any chance of doing justice to one's best duties, I mean that for the sake of the students it is so. I think that if the professors who have no endowments whatever were to receive such endowments, one effect would be to make them more independent of temporary difficulties with students, and they would look to the general interests of the College in a more effective manner. I think that that would be the general effect of it, although,

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F.R.S.*



no doubt, in some cases it might have the effect of neutralizing their motives for exertions. Such exceptional cases I fancy must be contemplated.

7166. If you were perfectly at liberty to define the conditions which you would consider most favourable to the thorough efficiency of the chair of chemistry, including in that efficiency experimental research, you would comprise endowment and likewise remuneration by fees?—Certainly; and I think it would be undesirable that any professor should be rendered independent of fees, and of that measure of appreciation of his work. I should not like it for myself, certainly.

7167. Has the College been enabled to afford your chair sufficient resources for the proper extent of laboratories and apparatus?—The public laboratory which is attended by the students is supplied by the College with the stock apparatus, which is kept up partially by a moderate sum, which is spent every year in renewing and repairing the apparatus. The Council are very considerate in the matter. I believe they have never refused anything in that way which I have asked for; but I conceive that that is only due to the fact that my requests have been exceedingly moderate, because I knew that I should very soon get to the limit of their power of supplying them. I do not remember a case of their declining to give me anything I asked for. On the other hand, the lectures on chemistry are not provided with any apparatus by the College; that is entirely found by myself at a considerable outlay. When I first was entrusted with the duties of that chair, in 1855, when Mr. Graham left it, there was no provision at all made by the College, although the College takes one third of the fees. As to the extent of the laboratories there are important wants for operations of greater nicety, but the general accommodation is not unsatisfactory.

7168. During your tenure of the chair have you had students who have come to obtain special instruction in chemical science with a view to future services under the Government?—I have of late years, on several occasions, had students who had passed an examination for the India telegraph service, and who were required, during an interval of time which was allowed for the purpose, to improve themselves further in certain prescribed subjects; and a certain number of those students have come to University College for the purpose of so improving themselves. I do not remember at present any other case of students coming to University College expressly for the purpose of qualifying themselves for a Government appointment.

7169. In that case did the Government, beyond the payment of the ordinary fees, make any bonus or other additional payment to the College?—None whatever. I believe that the Government allowed to each of those young men a fixed sum, and out of that sum each young man paid the fees as any other student would have paid them; they are on the same footing as the other students. A good many years ago, from the year 1849, when I first joined the College, to the year 1857 or 1858, a certain number of Inland Revenue officers were sent to the College for the purpose of attending classes, and they attended the classes of mathematics, of natural philosophy, and of chemistry, as well as of analytical chemistry. I do not remember other classes having been prescribed to them. The number amounted at one time to nearly 20, I think, and certainly my observations of their work have left very pleasant recollections; they certainly worked exceedingly well upon the whole at their chemistry.

7170. Having regard to those two instances in which young men intending to fill departments of public service were prepared for their special duties, would you consider it a proper and reasonable function which might be discharged by the College if adequate resources were provided by the Government for those cases?—Certainly, I think that even on its present footing the College is quite able to do efficiently the work of preparing

young men for the professional study of engineering, for instance. I believe that in that respect it is pretty much on a par with many other colleges; but I think that its efficiency would be increased considerably by the professors being put under more favourable conditions by Government aid for special service, and especially in the way of giving more than we now do of the applications of scientific principles to professional purposes. I think that there is useful room for the development of our functions in that way. I may give, as an example, the chair of Applied Mathematics and Mechanics, which is intermediate between the chair of pure science and the more professional study of engineering, and is a chair which really does not, from fees, bring a sufficient remuneration for such a man as we should wish to hold it, and it is a chair which, in fact, at present, is not occupied, but is vacant from that very circumstance, and yet it is a chair of considerable importance, although one not likely from fees alone ever to be sufficiently remunerative to retain the services of an efficient professor.

7171. Supposing that in that chair resources were available to render the illustration of applied mechanics much more effectual than it has hitherto been, you would expect a greater resort of students and greater success?—Yes, certainly.

7172. (*Professor Smith.*) Are we to understand that the chemical department at University College, so far as the payments to the professor and to his assistants are concerned, is entirely unendowed and entirely self-supporting?—Absolutely so.

7173. There is nothing given, so to say, from the capitalised funds or revenues of the College, but the building and the fittings and a part of the apparatus for the students' laboratory?—Quite so.

7174. Not the apparatus for lectures?—None for lectures. On the other hand, the College supplies water and gas and fuel gratuitously.

7175. So that, in fact, in return for the portion of the fees taken by the College, what the chemical department receives is the buildings and those things which you have mentioned?—Yes.

7176. Do you consider that other institutions which are better endowed, or are in receipt of Government support are in a position to compete with University College on terms which are disadvantageous to it; in fact, do you consider that in that competition a partly self-supporting institution, like University College, is placed at any disadvantage?—I think that the absence of such aid as the State gives in some other cases diminishes the extent of our usefulness by preventing us from doing as much work and as good work as we could do with such aid, but I do not know that students, before selecting the institutions to which they go, weigh the degree in which those appliances are supplied in the teaching staffs, so that I am not prepared to affirm that that circumstance influences, in any direct manner, the attendance of students, or their selection of a college. I think, however, that the selection of a school at which they will study is to a very considerable extent influenced by the prevailing opinion that the Government may favour the students who have been in any one over those who have been in any other in the way of giving appointments. For instance, it is occasionally stated that they go to a particular school in the place of another, because it is understood that those who go to that school will have the best chance of Government appointments, which those who go to another school will not have. Therefore, the name of a Government school tells a good deal in the competition, and the absence of Government aid prevents our making us efficient as we could do the means of attracting the public by evidences of usefulness in a direct way.

7177. In one respect which might influence the students there is no difference; that is to say, in the amount of the fees at endowed or Government supported institutions, you do not find, do you, that their fees are lower than those which you are obliged

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F.R.S.*

21 March 1871.



Dr. A. W.  
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21 March 1871.

to ask?—I am not aware that they are. I am not sure that in some cases they may not even be higher.

7178. Is the Council able to do anything in the way of providing apparatus for the original researches of the Professor and his most advanced students?—No, they do nothing whatever. I am not aware that they have even been asked to do so, so foreign is it to the subjects of which they have hitherto taken cognizance in the working of the College. I ought to limit my statement to chemistry. I am not equally cognizant of the other departments.

7179. (*Mr. Samuelson.*) Do you find, so far as chemistry is concerned, that parents sending their children to University College, pay much regard to the chance of their obtaining Government appointments?—I think they do. Parents are very apt to select the school to which they send their sons, from considerations of that kind, perhaps rather more in proportion than from considerations of efficiency in teaching, I should say. I do not think that, as a class, they take the highest possible point of view.

7180. Do you not mean to say that they look to a school which is likely to tend to their being employed when they finish their education?—Yes, to a school which has some slight chance of getting it for them.

7181. Do you think that they have any idea that chemists are likely to be employed by the Government to any great extent?—Yes; we must believe that they know that there are appointments of that kind under the nomination of the Government, which the students of a Government school are likely first to hear of, and to be offered.

7181a. Do they form any large proportion of the total number of posts and employments which are open to chemists?—They form one class, which is, perhaps, more prominent than the rest, because the applications of chemistry are so various, that most people do not know much about them, and they therefore value perhaps disproportionately those offices which are in the gift of the Government. With the manufacturers there is a great career for young chemists, but people do not know how to get at it, but an appointment under Government is something more definite, and something more attractive or tangible to parents as a rule, perhaps.

7182. But is it not the case that students who come to you are very frequently the sons of manufacturers, and, therefore, in the direct road for knowing the use which chemistry will be to manufacturers?—That is not unfrequently the case, certainly.

7183. (*Dr. Sharpey.*) The working room for students in the Birkbeck laboratory is sufficient to accommodate, how many?—24.

7184. I find that it has 1,200 square feet of area, which would make 50 square feet per student. Do you think that that is quite adequate for commodious working?—I presume that the area which you allude to includes the offices attached to the laboratory?

7185. No; it is only in the one central room, of course including gangways.—I think that the room allowed to each student is less than in the laboratories which have been recently built, and certainly it is found to be rather close. Sometimes it is a little difficult to get by, and difficult to move about, and a greater provision of space is now made in the modern laboratories. I remember that the laboratories at Bonn have much more space allotted to each student.

7186. You mentioned that in addition to the offices at present adjoining the Birkbeck laboratory, you think it would be desirable to have some others for special purposes: will you be so good as to mention those purposes?—For gas analyses, and for operations requiring high temperatures and requiring furnaces: the accommodation for both those purposes is at present scanty.

7187. There is a furnace room, is there not?—Yes, but it is not sufficient for our purposes for the organic combinations, and other things that have to go on there.

7188. As respects the instruction given in the Birk-

beck laboratory, it is continued throughout the day, is it not, for the students of analytical chemistry?—Yes.

7189. Then there is no special course adapted to the professions that you are tied to in any way?—None whatever.

7190. It would not be correct to say that your teaching was trammelled at all in order to apply it to the students of any particular profession?—Not in the least. In fact modifications in detail are made in the instruction to individual students in the laboratory. It is a general plan which is common to all, but modifications of details are made according to the personal circumstances and requirements of individual students, especially towards the latter part of their study.

7191. In the laboratory you have had students contemplating various pursuits in life, have you not?—Yes.

7192. And they obtained there a general chemical training, and also they were able to direct their attention to the specific objects which they had in view?—Yes, to some extent they have studied in the laboratory the methods which are applicable to their ultimate business pursuits. That has occurred especially towards the latter part of their period of study, but they have learnt the more general methods previously.

7193. The practical text books that are used in the laboratory are very much the same as those used in Germany, are they not?—With regard to the English text books for practical chemistry, I do not go much by any one of them. Several such books are in the hands of the students and are referred to, but I have never been able to adopt any one such book as a guide to the work of the laboratory; I have always had a system which was known to myself and the assistant, and which has been modified from time to time by the results of experience, and always growing in fact.

7194. Have you ever had occasion to give instruction to men who were afterwards to engage in the teaching of chemistry in schools of science?—Yes; in fact I have always in the laboratory some former students who assist me in teaching, and who thereby practise the business of teaching under my guidance.

7195. I refer more particularly to the teachers connected with endowed schools, for example?—No, I do not remember any case of such students being with me. I believe that young men who contemplate such posts as those do not, as a rule, study science so fully as we endeavour to teach it at the College; they are generally satisfied with less scientific instruction.

7196. Do you consider that the study of chemistry practically is not only desirable, but almost essential to a man who would give effective instruction to the pupils in a school?—If he were to teach even the elements of chemistry in a school, I think he ought certainly to have attended a practical class of chemistry at a college. I think that it is particularly important for a future teacher that his knowledge, whether it be great or small, of the science should be very thorough, so far as it goes.

7197. Have you formed any opinion of the length of time that a teacher would require to spend in a chemical laboratory, in order to qualify himself for the duty of teaching chemistry in elementary or endowed schools?—If such a student had already attended the classes of chemistry so as to learn the subject matter, I conceive that one year's practice in teaching, would, for such an appointment as that, be quite sufficient.

7198. What time ought he to work in the laboratory?—With regard to his own study, there is the summer class which consists of only 40 or 50 meetings of one hour each, and that supplies what would be for a great many schoolmasters exceedingly useful. I daresay for teaching elementary schools the attendance on such a class as that, after attendance on a course of lectures, would really be as much as it



would be desirable to require for the present; in fact, I should say it would be a better class than the laboratory itself, and do more for the time.

7199. (*Mr. Samuelson.*) Supposing an elementary schoolmaster to have been trained in one of the training colleges, to all of which, I believe, an elementary school is attached, and to have consequently acquired some practice in teaching in the school, would it be necessary that he should have any special instruction in the teaching of chemistry, or would the general course which he would follow along with other students be sufficient?—The only instruction in the teaching of chemistry, which I have ever afforded at the College is practical, and that has consisted in employing young men who have properly attended the lectures and gone through the courses in some teaching work under myself, using them as assistants. They get in that way the work of practical instruction in teaching like apprentices. I presume that there is scope for a considerable number of such men in the various classes of the College.

The witness withdrew.

Adjourned to Tuesday next at half-past eleven o'clock.

In the class of natural philosophy and in the class of mathematics, the professors could with advantage utilize such men. It would be a benefit to their classes, and it would certainly be a great advantage to the young men to be so employed.

7200. In the case of elementary schoolmasters, would you consider it essential that they should be so employed for a considerable time?—I think they might get great good by being so employed even for three months.

7201. Do you think that that would be ample?—It would certainly supply what would be for the present a considerable advantage to them; it would not make them accomplished teachers, of course, but I should think for a village schoolmaster that would be perhaps as much as one could reasonably expect at first.

7202. (*Chairman.*) Is there anything else which you would like to add to your evidence?—I am not aware of anything further.

*Dr. A. W. Williamson,*  
*F.R.S.*

21 March 1871.

6, Old Palace Yard, Westminster, Tuesday, 28th March 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

GEORGE BENTHAM, Esq., F.R.S., examined.

7203. (*Chairman.*) I believe you are President of the Linnean Society?—I am.

7204. There are at present two large national botanical establishments, one in London and the other at Kew. Do you consider the maintenance of both those institutions an advantage for scientific purposes?—Not as rival establishments for the same objects, but I think it very important that there should be two botanical establishments, one in London and the other at Kew, working in harmony together, but for different purposes.

7205. We shall be much obliged to you if you will be so good as to explain to the Commission your views as to the separate departments in the two Natural History collections which you would think it advisable to establish?—As an answer to that I should wish to make the following statement:—

The keeping up at the public expense of two great rival national botanical establishments, the one in London, the other at Kew, in a state of continual competition with, instead of aid to, each other, whilst a third independent one, also national, may occasionally come into collision with one of them, seems to be a waste of public money, without any advantage to science or to the public, and attended with many inconveniences.

At the same time two great botanical museums and herbaria, the one in connexion with the Natural History Museum in London, the other with the Botanical Gardens at Kew, working in harmony with each other, but for different purposes, and separated by a clear line of demarcation from the economic museums of South Kensington, would always be productive of great benefit to science and gratification to the public.

The main purposes of a botanical museum and herbarium may be said to be threefold: the study of plants, their comparison, and their exhibition; the first purely scientific, the second sometimes scientific,

sometimes popular, the third chiefly popular. For the first, Kew affords incomparable advantages; the second and third would probably be best promoted in town, provided always that the two establishments work in perfect harmony, with unity of plan, both in general arrangements and in matters of detail.

1. For the close study of plants—the only sound foundation upon which the science of botany can be usefully established—for their accurate determination and practical classification, the requisites are: that the herbarium should be as rich as possible, not only as to the genera and species, but as to the variations of all sorts and repetitions of the same form from different localities and stations; that the herbarium should be a single one, the geographical arrangement being kept in subservience to the scientific classification, and without any detached smaller herbaria, except such definite historical ones as only require occasional reference like the books of a library; that there should be good accommodation for the sorting of unnamed collections and fresh arrivals, ample means for the dissection and examination of specimens, not only by the staff of the establishment, but also by scientific botanists in general, who, under special regulations, are allowed to work in the herbarium, and store rooms for duplicates required for exchanges, &c.; that there should be in the same suite of rooms as the herbarium a botanical library, as complete as possible, and a series of drawings of plants, also as complete as possible; that the herbarium should be in close connexion with the National collection of living plants; and that it should be under the keepership of a resident scientific botanist, with the requisite staff of scientific assistants. All these essentials are at present afforded by the herbarium at Kew, in a degree far beyond what can be met with in any other establishment at home or abroad.

2. The comparison of plants, their practical and rapid determination without dissection, or the obtain-

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28 March 1871.



G. Bentham,  
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28 March 1871.

ing a general idea of natural groups from the order down to the species, as required by the general naturalist, by the follower of sciences in immediate connexion with botany, especially the palæontologist, or by the mere amateur, demands a very different herbarium and museum from that of the working establishment. It should consist of accurately named select specimens, representative of as many species or well marked varieties as possible, without duplicates in the same collection. It might be advantageously divided into two separate collections, one a general typical one, the other geographical. Separate collections also of leaves and of fruits, all accurately named, and so arranged as to enable them to be rapidly glanced over, would be most useful to the palæontologist. Such a museum would require no space for the sorting and determining of unnamed collections, nor for the storing of duplicates, and no provision for the dissection of specimens, except for the personal use of the keeper and his assistants, being supplied only with such tables or other appliances for consultation as are usually required in a library. Its library should be extensive, but select rather than complete, and should include various palæontological and other works on kindred sciences not required in the working herbarium. It should be in near connexion with the National Museums for kindred sciences, especially with other palæontological collections. The keeper should be a scientific geologist as well as botanist, and would probably require but one scientific botanical assistant.

3. The exhibition of plants, or rather of botanical specimens, is for the purpose of exciting the interest and gratifying the curiosity of the general public, and for this a herbarium, strictly so-called, is of no use, the public would never look beyond the outside of the cases. It requires the display in glass cases of such selected specimens of plants or their parts, accompanied by explanatory notes and diagrams, as may give at a cursory glance some idea of the characteristic features of the principal groups of plants, and to these might be usefully added a few specimens remarkable only for their beauty or singularity, for the purpose of attracting the eye and riveting the attention of the observers. As these specimens when once placed, require no further handling, and no care beyond the inspection of an ordinary assistant, and as the objects of visitors to such a museum would be much promoted by a ready connexion with the public museums in other branches of Natural History, it would seem highly advantageous that it should be attached to the herbarium for comparison and form part of the London Botanical Museum in close proximity to the National Museums of zoology and geology.

We have now no museum in any degree adequate to those two purposes of comparison and exhibition, but were the two National collections of the British Museum and Kew combined, all unnamed plants, duplicates, and specimens of interest only to the scientific botanist, removed to Kew, and in return, from the immense mass of materials there accumulated, the London herbaria completed by accurately named representative specimens, there would result collections richer in species, and far more useful than any actual continental ones; and as science advances and materials increase, these collections would be constantly kept up to the mark by named specimens from Kew, whilst their scientific arrangement and application to use could not be under a direction better qualified than that of the recently appointed Keeper of the Botanical Department of the British Museum.

In this London botanical museum would be also appropriately placed various pre-Linnean and other botanical collections, having only a historical or other adventitious interest, but there would be little use in attempting there anything corresponding with the Museum of Economic Botany, which has acquired so much importance, and is so well placed at Kew. That could only come into competition with the economic collections at South Kensington, but all prejudicial collision between the two is clearly avoided, and each

one will increase its own practical utility by strictly adhering to the rule, that at Kew the products are arranged according to the plants they are derived from; at South Kensington according to the uses they are put to.

I might mention, perhaps, in some respects how my experience has been formed; that it is not only from a knowledge of the herbaria of this country, but also from a practical acquaintance with most of the principal continental botanical museums; that is to say, I have worked for weeks or months together in the National and other principal herbaria of Paris, Berlin, Vienna, Munich, Geneva, and Florence, and I have examined into the working of the National herbaria of Leyden, Copenhagen, Upsala, Stockholm, St. Petersburg, and Madrid, besides those of several smaller towns in France, Germany, and Italy. During the last 50 years I have been a working botanist. My first botanical paper was published in 1821, and, for the last 37 years, botany has been the business of my life, and, therefore, I consider that few persons have had so much experience of the working of these establishments as myself.

7206. (*Professor Huxley.*) There is one paragraph about which I should like to make inquiry. You say in reference to the collection of plants which should be in the National Natural History Museum, that you think that the Keeper should be a scientific geologist as well as a botanist, and would require probably but one scientific assistant. I apprehend that you would propose to make the botanical collection in the National Museum subordinate to vegetable palæontology?—Very partially so—not fully subordinate to the palæontology, because that is only one of its objects.

7207. (*Dr. Sharpey.*) It should be subservient to it, I presume?—To a certain degree only. So far as it is a typical museum it is quite independent of palæontology for the use of a number of persons who do not want to go to work in the herbarium, but merely wish to look over a number of plants to get a general idea of their general aspect, and to compare their own specimens as far as they can do it merely by looking through them without examination. There are a large number of persons who have collected a few plants, and who want themselves to ascertain whether they have correctly named them, and who only require to look through a well-arranged typical herbarium to see whether they are right as to the genera or as to the species; and for that a large working establishment like the one at Kew is not suited, because there are a great mass of specimens of the same species which take a long time to go over. That is one of many purposes for which a herbarium in London would be eminently useful for amateurs and others, quite independently of palæontology; and, therefore, I can by no means consider it as entirely subservient to palæontology.

7208. (*Professor Huxley.*) Would it not be a better plan that the Keeper should be a botanist, and that he should have assistants who had specially devoted themselves to the palæontology of plants?—Of course, for the palæontological part he would require palæontological assistants, and for the botanical part a botanical assistant; but I think it very essential that he himself should be both.

7209. Would you make the Keeper of the Botanical Collection in the National Museum subordinate to the Superintendent of all the collections there, or should he be in any way subordinate to the Director of Kew?—That is a very delicate question, in which very many interests are concerned. Of course, so far as the botanical collection is concerned, it would be very essential that he should work in harmony with Kew; and therefore, if the two were under one head it would be an advantage. On the other hand, it requires that he should work in harmony with the zoological and geological museums, and be in close connexion with them; and that is a reason for the whole being under one management; but that is a complicated question, rather beyond my province, excepting so far as I think, that



every precaution should be taken that the two botanical departments should work in harmony together.

7210. There would be a little difficulty in administration, would there not, if there were in the same building a Keeper of the collection who was wholly independent of the general Superintendent?—There would be very great difficulty, and, therefore, I think it would never do to place the London collection under the direction of the Director of Kew.

7211. I perceive that you do not propose to place in the National Museum anything corresponding with the Museum of Economic Botany?—Certainly not. I think that the two collections that we have are quite sufficient for that purpose. It is very essential that they should be as extensive as possible, and it would

The witness withdrew.

JOHN BALL, Esq., M.A., F.R.S., examined.

7213. (*Chairman.*) I believe you have devoted much of your attention to the natural sciences?—Yes, mainly to botany.

7214. Have you considered the question of our National botanical collections?—In some degree I have. I have had occasion to personally make use of collections in various countries, and necessarily also at home. I have not been living in England much for the last 10 years, but I know enough of the Kew herbarium and collections generally to be pretty familiar with them. I believe I may say that it is admittedly, not only the richest, but also in every way the most valuable and available to science of any collection in the world.

7215. Are you acquainted also with the collection at the British Museum?—Partially.

7216. Do you see any great advantage resulting from our having two National collections, one at Kew, and the other connected with the British Museum?—I think it desirable that there should be a collection, speaking more strictly, an herbarium, a collection of dried plants made as complete as it can be in the metropolis; but I do not think that it is desirable that there should be anything like a competing collection. The collection at Kew is more valuable to science, being there close to the great garden, possessing as it does materials which it would be in vain to try to collect, even at any outlay of money. You could not bring together again such a herbarium as there is now existing at Kew. The British Museum contains certain valuable and interesting collections, some of them unique, and it is, I think, generally felt by the cultivators of science that it would be very desirable that they should be united to the unrivalled collection at Kew, while at the same time I consider that the collection at the British Museum might be made more valuable to science, and to scientific men than it now is, even although you took away from it some portions of the materials that are now there.

7217. We should be glad to know your views as to the principles upon which the two collections should be organized?—I would say that it is by no means a conclusion come to exclusively from observing our own collections, but I have everywhere seen that the keeping up of a great Natural History collection in any branch of science is a thing that requires a concurrence of favourable circumstances, that are very rarely united. I am familiar with the collections in various parts of Europe, which, in spite of the materials being there, are not made so available to science as they might be and as they should be, not because they have not eminent scientific men connected with them, but because the system is not adequate to attaining a most difficult object,—namely, maintaining a very large collection in a complete state available for reference. I will not go into detail as to those which I have in view at this moment in Paris, in Germany, and in Italy; but I may say that very often it depends upon the traditions of a place. We

be too much to require the nation to keep up three collections. Two collections for two different objects are very useful, and these two objects may be clearly defined as I have above stated, by the products being arranged in the one, as at Kew, according to the plants they proceed from, an object which, although a purely scientific one, has great practical advantages; and in the other, as at South Kensington, according to the uses they are put to, for food, for clothing, or for other purposes.

7212. (*Chairman.*) Are there any points in this paper on which you would wish to make any further observations or explanations?—There do not occur to me to be any.

G. Bentham,  
Esq., F.R.S.

28 March 1871.

J. Ball, Esq.,  
M.A., F.R.S.

had in the British Museum the most eminent botanist of the present century, and, perhaps, of any century, Mr. Robert Brown, unrivalled for his powers in his own department, but yet he had not that combination of qualities which makes a good administrator of a National collection. And I venture to say that the traditions of the British Museum have not been favourable to making the collections there as available for the general purposes of science as might be desired. At the present moment there are two very competent gentlemen at the British Museum, but I do not think that it would be within their power to make the collection there at all a rival to that at Kew. Having one National establishment such as Kew, which I take to be as near perfection as it is possible in human affairs to attain to, it would be easy from their rich stores of duplicates to supply not only the British Museum, but such other institutions as may be fixed upon, and as it is desirable to aid in that way with correctly-named duplicates, which would enable you to have herbaria for reference, not only at the British Museum, but also at other centres that may be fixed upon in the United Kingdom. I believe that that could be done; of course, there I speak under the correction of those who manage the department; but I believe it could be done without any large increase to the present establishment at Kew. The tendency, perhaps, of National collections and public establishments placed under men who are themselves distinguished in science, and who naturally are carrying on original inquiries or studies of some kind, is to let what appears to them to be in great measure the mechanical work fall into arrear; and it is only when a very excellent system has been well established, and has become part of the tradition and rule of the place, that you can combat this tendency, not only of the chief but of his assistants. They are generally young men of zeal for science, and who are anxious to distinguish themselves;—(I have seen it over and over again in foreign museums;) and their tendency is to give as much time as they can to their own inquiries, and to let, in a great measure, the mechanical work of keeping up the collection fall into arrear. At the present moment, I happen to know that there are in the British Museum collections of plants of very great interest, one of which I had occasion to examine lately, but which I believe had not been opened since the time of Sir Joseph Banks. I believe he was the last person who opened the parcels which I saw within the last fortnight.

7218. With regard to such collections as those, would you think it desirable that they should be transferred to Kew?—Decidedly.

7219. Can you recommend the laying down of any rules by which the tendency of which you have been speaking could be counteracted?—I think that if the National collections were under the immediate supervision of a competent officer, feeling a direct sense of responsibility, that is the best security that you can



J. Ball, Esq.,  
M.A., F.R.S.

28 March 1871.

have. I venture to doubt whether the present mode of governing the museum is very favourable to that.

7220. Do you think that there should be any connexion between the Director of the establishment at Kew and the Keeper of the botanical collection in the British Museum?—It is decidedly desirable that there should be a connexion, but I am not prepared to suggest the precise nature of the connexion, or how it may best be established. The two institutions may very easily serve each other. It happens that the gentleman who is, I believe, either actually appointed or about to be appointed (for I am not quite aware of the fact) to the head of the botanical department in the British Museum, is an eminent cultivator of fossil botany. There is no objection that I can see, and no reason why that department should not remain at the British Museum. Its essential function is subservient to the geological collections, rather than to the study of recent plants. Anyone at the head of such an institution at Kew, could easily aid in various ways that particular department of science which might have its centre at the British Museum, and *vice versa*.

7221. (*Professor Huxley*.) I think I heard you express certain dissatisfaction with the government of the British Museum. What mode of government would you propose as a substitute for the existing one?—I have very long been of opinion, which I believe is shared by many cultivators of science, that it is most desirable that the management of the British Museum should be directly under a person responsible in the fullest sense to a public authority. I take it that it is next to impossible that a body constituted as the present Trustees of the British Museum are, should feel themselves competent in the first place to decide a variety of scientific questions. It is true that amongst their number there have been, and probably may be, other persons of distinction in science (not many but few), but I take it that there is not an adequate security for the public, and above all I do not think that, placed as they are, they do as a matter of fact, or that they are likely at any time to resort to the proper means for getting the very best scientific advice upon questions connected with any particular branch of science. If the persons who have the control of a public establishment are fully aware of their own ignorance, they go to the best authority to obtain knowledge, but I think that the tendency of the mode of government is to lead the Trustees to think that they contain in their own body that requisite means for solving any question connected with science that arises, and I do not think that they do possess it or are likely to do so.

7222. Then are we to understand that you would put the whole government of the Natural History Museum in the hands of a Superintendent who should be directly responsible to a Minister?—Yes, I do think so; perhaps I may add that both in relation to that and other questions in which the government of the country comes into contact with science, if science is to be aided effectually and at the same time controlled effectually, there should be some permanent officer in the department of the government that has its relation with science, whose duty it should be and who should be responsible for making himself generally aware of the state of science and the doings of its cultivators, and who should be the proper person to advise the government, not as to the best mode of deciding a strictly scientific question, but as to where the means for solving it are to be had. I look upon it at present as being a wholly haphazard matter how questions of science or connected with science and affecting the progress of science are decided in the public offices, and I speak from some slight personal acquaintance with the matter during the short time that I was in the public service in Parliament.

7223. Would not the Council of the Royal Society be a body fitted to give advice of the kind you are now describing; I mean advice which should enable the Government to lay its hand upon men who are proper

to do a particular thing?—Yes, the Council of the Royal Society no doubt as a body are highly competent; but whether, for the daily transaction of business, it would be convenient and suitable to apply to them, is another matter. What happens in a public department is this: the business comes in the shape of papers that are presented. Some of them may be of considerable importance and weight, and in such cases it is quite conceivable that whoever the chief of the department might be, should say "This is a question to refer to the Council of the Royal Society," but the questions that practically arise are of every degree of importance, from the largest to the smallest, and yet the smallest may not in themselves, perhaps, be at all indifferent, or fit to be cast aside, or neglected, or ill done. I doubt whether it would be possible to refer every question that arises, especially if it be true that we may look to some further relation between science and the State than there has been, and something of a more organised relation. I doubt whether it would be possible to refer the ordinary papers of the department to the Royal Society. I am not quite sure that dissatisfaction and difficulty might not arise from the fact that the Council of the Society, however weighty and respectable a body, would not be considered as having that complete responsibility for their advice, except as to weighty matters, which an individual, properly chosen, would have.

7224. I am not suggesting that the Council itself should give advice upon the matter, but only should point out to the Government the persons who are competent?—I feel that I have been corrected properly. No doubt that would be a different thing, but I still think that there are a large number of what may be called small questions, and yet not unimportant questions, that actually arise at present, or may arise and probably will arise in greater number hereafter, and to which you would scarcely apply such a weighty machinery as the Council of the Royal Society to deal with.

7225. Would you propose to appoint a Board of Visitors to the Natural History Museum, supposing it is put under one head?—I do not at present see any objection to that course, but I have not fully considered it.

7226. Do you think that the authority of the Trustees, or rather I should say the relation of the Trustees to the museum might be modified in such a manner as to convert the Trustees, properly appointed, into a Board of Visitors?—Yes, I am inclined to think that that might be done with advantage.

7227. You would keep the general work of the botanical establishment at Kew, I presume?—Yes, decidedly. Kew, as a matter of fact, is the place in Europe to which all cultivators of botany who have important work on hand do resort. Botany is not a science which has a very numerous body of cultivators, but in proportion to the numbers Kew has a large number of students from foreign countries, and visitors who are most of them eminent men of science who come there, and it is most desirable not only that it should be maintained, but, if possible, made a still more complete collection there. Perhaps, if I may recur to what I said, in order that it should not be understood that I am wishing to make any charge either against the past or present management of the botanical collection in the British Museum, I may say that it is a matter of some very considerable difficulty to arrange and name collections which arrive from distant and little known countries, and that can be done with anything like ease and correctness only where there is already a very large mass of materials arranged. Any gentleman who has cultivated any branch of natural history, and knows what it is to get, we will say, 100, or 200, or 300 objects coming from a distant and imperfectly known country, unless he has at hand collections of a very large description, enabling him to see the place of those new objects in the general series of natural productions, will feel what an enormous difficulty there is, and how much time will be wasted. I venture to say that the unnamed collections in the British Museum could by the very same person be



named and classed, and placed in one quarter of the time at Kew that they could be at the British Museum itself, by the same person acting with the same motive for zeal and efficiency.

7228. I presume you would send all unnamed collections down to Kew for that purpose?—Decidedly.

7229. There is a large accumulation of objects of that kind in the British Museum, is there not?—There is an accumulation. I cannot venture to say how large it is. I know, because I have had a recent instance of one, that some very interesting collections have, I will not say disappeared, but cannot now be found, and they may very possibly be lying in cases there.

7230. (*Chairman.*) Do I understand that you propose that the collection at the British Museum should be supplied mainly from the collection at Kew?—There would be no reason for removing the named collection at the British Museum, but I should propose to add to it and complete it as far as may be from the collections at Kew. It would be very much enlarged, and it would still require the services of, we will say, two or three competent persons to keep it in order, and to correct errors which may arise, and from which no collections are exempt. Of course, I presume it would not be possible to refuse collections specially given hereafter to the British Museum, and, therefore, there should be a small staff there adequate to keep them in order.

7231. You would propose that the British Museum should still receive donations specially offered to it rather than forward them to Kew, as a matter of course?—What I would suggest is with reference to the unnamed collections sent home by travellers, who express a special wish that they should be at the British Museum, I should recommend that, at all events, they should in the first instance go to Kew, and be dealt with there, and then sent in accordance with the wishes of the donors to the museum. That, I presume, would not be considered a departure from their special wish but I should decidedly prefer that those who did make gifts to the nation should let them go to the central establishment at Kew, as I believe most present travellers or officers in the public service do.

7232. Is there any other point upon which you can make any addition to your evidence as to your views with regard to the characteristic distinctions between the two collections which you think ought to be mainly kept in view?—I do not know that I can add anything of consequence. I may perhaps say that I think it would be very easy to make the collections at Kew available, not merely to complete the collections at the British Museum, but also for other institutions in various parts of the empire. I believe it would tend very much to the progress of science if collections, for instance, even of the ordinary plants of our own islands, or of Europe, could be sent out to the colonial institutions, and it would tend to increase the intercourse that there is between naturalists at home and those in our colonies, or distant settlements.

7233. (*Professor Smith.*) You stated, did you not, that you thought it desirable that there should be some permanent official to represent and advise the Government in its relations to science?—Decidedly.

7234. Is it your impression that such a person should be himself a scientific man, or merely an official charged with that express duty?—I think it would be very strange if, in the selection of the official, reference were not made to his general acquaintance with science. I do not think it is desirable that you should select an eminent cultivator of science, because I frankly say that I think that would be throwing away his services. The duty of an eminent cultivator of science is much higher than that of an official advising the Government which pays for it. I may say that I was for two years Under Secretary for the Colonies, and, as I informed my Chief on entering office, I resolved to perpetrate as

many scientific jobs as I could while I was there; but many of them required the concurrence, either of the Treasury, or of other public departments; but I felt how completely in the dark most of the excellent officials with whom I had to deal with respect to those questions were, that their concurrence or non-concurrence depended upon anything rather than a full estimate of the real value or propriety of the suggestion or step that I proposed to take, and I think that would not be the case, and ought not to be the case, if you had a person who felt that he was appointed to his office expressly for the purpose of being competent to give sound advice, not as to a special point of science, but as to its general bearing upon either the scientific education of the country, or the national collections, or other matters which it was admitted ought to be taken note of by the Government.

7235. I understand that you have expressed some objections that there would be to employing the Council of the Royal Society as the body to which the Government should apply in asking advice. I wish to ask you if you think that a Scientific Council constituted of scientific men, and of cultivators of science, could be formed, that would be of use in giving advice to the Government through the intermediary of such an official as you have described?—I do not know that there would be any advantage in replacing the Council of the Royal Society by a Scientific Council, and I must have expressed myself ill if I did not say that in all important matters—matters of sufficient gravity—I should consider that the Government ought to have the assistance and advice of the Council of the Royal Society, only I do not think that it is a body which you could turn to at every moment. With regard to current questions which arise, which may have a very considerable interest for science, but yet are not of a sort that you would go and refer them to the Council of the Royal Society, and have discussed, and then referred by them to someone else; it strikes me that that would be a cumbersome way of dealing with the matter, and one that practically would not be resorted to; in fact, it would not be done.

7236. So far as a Council of Scientific Men could be of service you would be satisfied with the Council of the Royal Society?—Fully. I think that it fairly represents the highest scientific ability of the country.

7237. (*Chairman.*) Are you able to offer further suggestions as to the character of the office which you would like to see established?—The sort of position is that of permanent under secretaries or assistant secretaries. I should not be prepared to give a specific suggestion on the subject, but that there should be a public officer both in a permanent position, and in such a position that his advice would be sure to be listened to. This is an opinion which I have long held.

7238. Do you think that it would be possible to find a single man competent to give advice on the great variety of scientific questions that might possibly arise requiring consideration?—I think it is quite essential that the person should be one who was aware of the depth of his own ignorance upon many subjects, and who would not venture rashly to give advice, but would say this is a point upon which we should apply to Professor So-and-So, or to Mr. So-and-So. I venture to assert that if you were now to inquire in the House of Commons you would scarcely find one out of 100 members of that House who could say who is the greatest authority in mineralogy, or entomology, or in any other branch of science in England; they would not have the slightest idea. As a general rule our public men, owing to their previous education, and to the fact of their time being very fully filled up from the time that they enter public life, really do not know what is going on in science, and who its most eminent cultivators are, or where to turn for anything like an authoritative opinion.

The witness withdrew.

J. Ball, Esq.,  
M.A., F.R.S.

28 March 1871



T. Thomson,  
Esq.,  
M.D., F.R.S.  
18 March 1871.

THOMAS THOMSON, Esq., M.D., F.R.S. further examined.

7239. (*Chairman.*) You are no doubt acquainted with the National botanical collections, both at Kew and in the British Museum?—I am to a certain extent with that in the British Museum, and very well with that at Kew.

7240. Do you consider the two collections to be competing?—In one sense, and only in one sense, they may be said to be competing, in so far as they would both purchase collections now-a-days, but in no other sense are they at all competing. There is a perfectly good understanding between the two. The Kew collection has only recently been a government collection, it was for a very long time the almost entirely private collection of Sir William Hooker, and it was only on his death that it assumed fairly the position of a government collection, having been purchased from the owner.

7241. Do you consider it desirable that the two collections should both be maintained?—I think not.

7242. What arrangements would you suggest as to the future organisation of the national botanical collections?—I speak without the same intimate knowledge of the British Museum collection that I have of the Kew herbarium, that the one at Kew is at present the more available for scientific research of the two, and I think that it is at least quite as accessible to scientific men as the other. I am, therefore, strongly of opinion that it would be most desirable that some at least of the British Museum collection, if the Natural History department is removed, should go to Kew, so far at least as it would not be merely a collection of duplicates, and I think it would be very desirable so far as it is a duplicate collection (and it would be so to a very large extent), to have a separate collection in London for reference; but for all scientific research, I think Kew is quite as accessible and quite as available and more convenient for botanical specimens than anywhere in the immediate neighbourhood of London.

7243. While you would make Kew the main botanical collection of the nation, you think that there would be advantages in also keeping up a botanical

collection to a certain extent in the British Museum?—I think so, but not independently of the other. I think wherever the head authority is, whether the head authority was at Kew or in London itself, the two should be correlated, and should work in unison, and that one of them should be the head establishment and the other the branch.

7244. Would you propose that there should be any characteristic differences in the character of the two collections?—The palæontological department has never been attended to at Kew, and I think it would be desirable that that should remain with the Natural History department of the British Museum.

7245. You would not have Kew concern itself with palæontological collections at all?—It never has, and I do not think it would be desirable to make any difference in that respect from what is the present system.

7246. Would you arrange the palæontological collection, so far as botany is concerned, with the other botanical collections at the British Museum, rather than have it in a separate department?—That is a point upon which I am not able to give any definite opinion.

7247. Would you think it desirable that the Superintendent of the botanical department of the British Museum should be appointed by the Director of the Kew establishment?—I do not know that he should be appointed by the Director of the Kew establishment, but if Kew is considered as the head establishment, he should be subordinate to him, I think.

7248. He should be under his direction you think?—Yes, he should be under his direction certainly, I think. In whatever hands the appointment lies is a different question.

7249. Are there any other points upon which you would wish to explain your views with respect to the national botanical collections more fully, or have you sufficiently explained the general results of your consideration of the subject?—I think so. I do not think that I have anything to add to what I have said.

The witness withdrew.

Adjourned to Friday next at half-past 11 o'clock.



6, Old Palace Yard, Westminster, Friday, 31st March 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D., Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

J. GOUGE GREENWOOD, Esq., B.A., examined.

7250. (*Chairman.*) You are a fellow of University College, London, and Principal of Owens College, Manchester?—Yes.

7251. Will you have the goodness to describe the origin and growth of that College?—The College was founded by a bequest made by Mr. John Owens, a merchant of Manchester, who, dying in 1846, bequeathed the greater portion of his property to Trustees named in the will, a part of them his personal representatives, and a part of them persons officially designated, to found within the limits of the parliamentary borough of Manchester, or within two miles therefrom, a College for the purpose of giving instruction to young persons of the male sex, not younger than 14 years of age, in all such branches of learning as were then or might be thereafter usually taught in the English Universities. That definition of the intention of the founder I need not say has been carefully attended to by the Trustees. The College was not opened till 1851, and the cause of that somewhat long delay was that the Trustees felt themselves called upon to make very extensive inquiries into the proper course to pursue as regards the subjects of study. In the first (incomplete) session, the number of students was small, only 25 in number; the number in the present session, 1870–71, is 261. In 1852–3, evening classes were established. In the first two years these classes were held in classics and mathematics only; in fact they were established for the use of schoolmasters only, and these were the subjects most desirable for them at that time. In the first year 28 members only attended, but in the course of a few years the classes were thrown open to all applicants, and the range of subjects taught has been gradually enlarged so as to include the whole of those comprehended in the day classes. The number of students now in the evening classes is 527. I may remark that in 1861 the scope of the evening classes was extended through the incorporation of an institution called the Working Men's College, conducted by the Professors of Owens College, and other gentlemen in Manchester. Thus the number of students in the evening classes was largely increased, and at the same time the fees were lowered so as to bring them within the means of a larger number.

7252. Have the directions of the founder of the College been followed?—They have, both in letter and in spirit.

7253. Has the locality of the College had any influence upon the character of the education provided?—Yes, I think a very marked influence in this way. The Trustees of course felt bound at once to introduce into the curriculum of the College all the subjects understood as those which a liberal college takes up—that is to say, classics and mathematics, pure and applied, logic, and mental and moral philosophy, history, English language and literature, chemistry, natural history, and modern languages; but, whereas natural philosophy was at that time treated as a branch of mathematics, and chemistry was regarded in the light of a chair of the second and not of the first order, in the course of about 10 years a great change was made. On the one hand, chemistry rapidly developed into a subject of the greatest importance with us. We were fortunate enough to have Dr. Frankland as our first professor, and not less fortunate, on his removal to London, in obtaining as

his successor Dr. Roscoe; and when the development of the department of chemistry made it seem to us desirable to separate natural philosophy from mathematics, and make a distinct chair of it, it will easily be seen how the peculiar demands of Manchester would lead to the development of those two professorships on a more important scale, as compared with the rest of the College, than might have been necessary elsewhere. I should say that there was no conscious effort on the part of the Trustees or the Professors to develop that side of the College rather than the rest; the process took place spontaneously, and these classes at once became very popular. The professors of chemistry and natural philosophy, Professor Roscoe and Professor Clifton, were determined at the same time to maintain the thoroughly liberal aspect of those studies; to treat them, that is, in a rigidly scientific manner, and not either in a superficial and popular style, or with a direct regard to their industrial and mercantile applications. But in spite of that the number of students in those classes has gone on increasing from year to year, and those professorships now rank among the most important chairs in the College.

7254. Are you of opinion that the study of both literature and science derives advantage from being combined in one institution?—I think so very confidently, and upon these grounds. In the first place, as regards the bearing of the combination on the chairs of science, it seems to me that the danger, which is certainly a very real one, that the applications to practice of Applied and Experimental Science might be more regarded than the scientific aspect of the same subjects, would operate more strongly in a college in which science only was taught; and the professors, in spite of their better judgment, could perhaps hardly avoid teaching science in a fragmentary and diluted instead of in a more methodical and systematic form. It appears to me, therefore, although it sounds like a paradox, that it is more important that scientific studies should be treated as portions of a university and liberal education in a neighbourhood like that of Manchester, where the practical demands are stronger, than in other parts of England, where there is less tendency to fall into that mistake. Then, on the other side, namely, on the side of literature studies, the combination appears to me to be almost as much to be required, and for a corresponding reason. I am Professor of Greek in Owens College, and can speak with some experience on this subject. I believe that students of classics themselves would admit that Literature studies have their dangers equally with the studies of Applied Science. The tendency to call into too exclusive operation one set of mental faculties, the æsthetical side of the mind, for instance; and again the tendency to lean upon authority and tradition, rather than to bring into play the correctives supplied by inductive processes, are very strong in students of literature studies. But classical studies have aspects in which inductive methods can be brought into play; as, for instance, philology has its distinctly scientific side, and if classics are taught in a college where scientific studies have their full share of attention, there seems to me to be a greater chance of the scientific aspects of philology being also well attended to. One

J. G. Greenwood, Esq., B.A.

31 March 1871



J. G. Greenwood, Esq., B.A.  
11 March 1871.

can hardly help concluding that the great and extraordinary impulse given in the last 30 or 40 years to comparative philology, as expounded by persons like Professor Max Müller at Oxford, and Curtius and others in Germany, is due in no small degree to the reaction of the methods of experimental science upon language studies. That I think is a matter of fact which does not admit of any doubt, and, for that reason, I think that classical students, no less than men of science, would desire that any College for the higher education should give fair room to both of those studies. And then, if I might touch upon another aspect of the same question, not only do I think that men of science undergo a useful, I will not say corrective, but a useful influence from the co-existence in the same College of language studies, but that for another reason also they should desire this combination. Men of science of the highest kind would certainly be the last to say, as some are inclined to say for them, that their studies are chiefly or solely worthy to be promoted, because of their direct tendency to promote the material interests of the population. They would stoutly resist any such claim if made, as it would at first sight seem, in their favour, and I am sure they would maintain that from the point of view of culture and disciplinary methods, as well as from the point of view of material interests, Applied and Experimental Science is entitled to hold a very important status. For my own part, I feel this strongly, and on estimating, as I can fairly do, the effect on our own students for the last 10 years of the introduction into our regular curriculum of a large amount of Experimental Science, I can safely assert that the influence of that introduction on the students, not merely on those who are going into some scientific profession, but on the ordinary students, has been of the most beneficial kind; and, therefore, it appears to me that the claim of the studies of Experimental Science to rank very high in respect of culture and discipline, is promoted by the combination in one academical institution of the two not rival but parallel branches of education. One might illustrate that from the history of the last three or four centuries in the matter of other professional and *quasi* professional studies: I mean those of theology, jurisprudence, and medicine. No one can fail to see that on the one hand those three great professions have benefited enormously from the fact of their being recognized as having their place in the scope of a liberal education, and it is equally clear upon the other side that the mental discipline of universities and colleges has been greatly promoted by the combination of those professional studies in their ordinary curriculum.

7255. What conclusions on this head has the experience of our older Universities and of the German Universities led you to form?—I think that the experience of the English and German universities is unquestionably in support of the conclusions which I have offered. For instance, nothing can be more incorrect than to suppose that in Germany the great attention paid, of late years comparatively, to scientific and experimental studies is limited to the new institutions called Polytechnica. Although there have been founded in many parts of Germany the special institutions called Polytechnic Schools, yet the older Universities of Berlin, Göttingen, Heidelberg, and Leipzig, have all given the most cordial welcome to the new studies, if I may use the phrase, and have given them an ample share, both of endowment and of academical importance and dignity. In England also, it is well known that Oxford, for some years past, and Cambridge, more recently, are showing great energy in the same direction. From what I have heard from those whom I know at Oxford, the classical men are quite devoid of any feeling of jealousy of the new studies or their representatives. In our own College the same thing is true. We find no difficulty whatever in reconciling any conflicting claims of the two sides. Each is conscious of the great value derived to itself from the other, and the

only limit to the development of both is, of course, that of the teaching power and endowments.

7256. I understand you to express a very decided opinion that it is desirable that both literature and science studies should be combined in one institution, but I do not exactly understand whether you think it desirable that each student should study both literature and science?—It would be impossible, perhaps, to lay down an infallible rule upon that head. It would be quite clear, for example, that there must always be a certain residuum of students who, for reasons derived from their future professions, have paid, and will pay, a much larger amount of attention on the side either of literature studies on the one hand or of science on the other. Those who are going to the bar, or those who are about to take holy orders either in the Church of England or in any denomination of nonconformists, will, of course, naturally be disposed, and reasonably so, to give much more of their time to literature studies than to science studies; whilst, on the other hand, those who are about to become manufacturing chemists, or engineers, or machinists, will have the opposite tendency. But, allowing for some little play of a man's preference in those two directions, it does appear to me that it is desirable that some pressure should be used by the heads of institutions like Owens College to induce the science men to take up some share of literature studies, and to induce the arts men to take up some share of science studies.

7257. Are your students at liberty to select what subjects of study they themselves prefer?—They are at liberty, absolutely. The only limitation to their discretion is in this way, that we give certain pecuniary advantages in the shape of composition fees to those who take up those lines of study which we ourselves recommend under certain conditions. And it may be pointed out that our regular courses are directly fashioned to meet the requirements of the London University degrees, and that, as the London University demands of all those who seek its degrees, whether in arts, or in science, or in law, or even in medicine, they must first of all matriculate, every holder of a degree in the University of London must needs, at one stage of his preparation for the degree, have gone through a preliminary culture both in science and in literature. Thus, a bachelor of science must have shown himself possessed of the minimum of classics, and a bachelor of arts or laws, of the minimum of science. Therefore, in this way, our own conclusions are materially aided by the line taken by the University of London.

7258. Will you state what endowments or other sources of income Owens College possesses as applicable to instruction in science?—I have prepared a statement in accordance with the request of the Commission, received some months ago and dated June last year, that we would furnish the Commission with a statement of all sums applied to the advancement of science or scientific instruction in Owens College, whether derived from endowments or parliamentary grants. The Commissioners wished that this should be stated in detail as far as possible, and we have prepared for the Commission a table which sets forth that our funds are derived first of all from the endowment left by the founder; secondly, from endowments and contributions given at various times by other benefactors in support of his endowment; and thirdly, from fees paid by the students. Under the first head details are given, from which it will be seen that we have an estate of 91,325*l.*, and that the gross income derived from that, which is the founder's endowment, is 3,197*l.* This income is applied to the payment of the fixed salaries of the professors and assistant lecturers, and of the general expenses of management, including therein the appliances (apparatus, models, specimens, diagrams, &c.), and the current working expenses of the several scientific departments, and also the maintenance of the library. An estimate of the proportion of the total expenditure which is incurred for scientific instruction is given in the accompanying



return marked C. Secondly, the endowments and contributions given at various times by other benefactors, which are applied wholly or in part to scientific purposes, consist of the following sums:—First, the auxiliary fund of about 10,000*l.*, out of which the following sums have been expended on science: 2,790*l.* in the erection and fitting up of a chemical laboratory, and 451*l.* in building and fitting up class rooms for the engineering and mechanical drawing classes, making a total of 3,242*l.* spent upon the science department exclusively. The balance of this contributory fund amounts to 6,533*l.*, giving a gross income of 245*l.* This is carried to the general account and applied to the same purposes as the income derived from the founder's endowment. Then there are several sums amounting to 350*l.* per annum, contributed for a period of four or five years in support of the science department. Next comes the Engineering Instruction Fund of 9,472*l.*, producing a gross yearly income of 378*l.*, which is applied, of course, wholly to the payment of the salary of the Professor of Engineering, and of the expenses of his department; fourthly, there is another engineering fund, the Ashbury endowment of 5,000*l.*, subject to the payment of 1,000*l.* to another institution, which, when realized, will be mainly applied in engineering scholarships. There are besides some minor sums. Then follows the Dalton fund of 4,125*l.*, giving an income of 165*l.* per annum, applied to two scholarships of 50*l.* each per annum in chemistry, to scholarships in mathematics and natural philosophy, and to a prize in natural history. Last of all (Table B.) come the fees paid by students in science classes in the present session, which fees amount to 1,946*l.*, out of which 1,463*l.* is payable to the professors of those classes, and the balance, 482*l.*, is applied to the general expenses of the College. Another table, Table E, shows the proportions in which the income of the endowment fund is apportioned to the science side and the non-science side of the College respectively. The result is this, that six science professors and five assistant lecturers on the science side receive among them 2,100*l.*, whereas seven professors of the non-science subjects, and one assistant, receive among them 1,600*l.*; so that 2,100*l.* are bestowed by way of stipend to the science professors and lecturers, and 1,600*l.* to the arts professors and lecturers, showing that the science side has a tendency to encroach beyond the half which would, in the nature of things, have been its proper share. [*The witness delivered in the following statement:—*]

THE OWENS COLLEGE, MANCHESTER.

The sums applied to the advancement of science or to scientific instruction in the Owens College, Manchester, are derived from the following sources:—

1. The endowment of the Founder of the College.
2. The endowments and contributions given at various times by other benefactors.
3. The fees paid by students.

1. The endowment of the founder consists of—

£	s.	d.	
42,400	0	0	new three per cent. annuities.
2,769	18	7	three per cent. consols.
46,049	7	6	India four per cent. stock.
105	17	3	cash in bank.

Total £91,325 3 4

And the gross income arising therefrom is 3,197*l.* 1*s.* 5*d.*

The income is applied to the payment of the fixed salaries of the professors and assistant lecturers,\* and of the general expenses of management, including therein the appliances (apparatus, models, specimens, diagrams, &c.) and the current working expenses of the several scientific departments, and also the expenses of the library.

An estimate of the proportion of the total expenditure which is incurred for scientific instruction is given in the accompanying return marked C.

\* See Table E. in page 478.

2. The endowments and contributions given at various times by other benefactors which are applied wholly or in part to scientific purposes, consist of—

J. G. Greenwood, Esq., B.A.

31 March 1871

- a. The auxiliary fund, out of which the following sums have been expended:—

£	s.	d.	
2,790	19	8	in the erection and fitting up of a chemical laboratory; and
451	4	5	in building and fitting up class rooms for the engineering and mechanical drawing classes.

£3,242 4 1

The balance of the fund amounts to 6,533*l.* 6*s.* 1*d.*, from which a gross income of 245*l.* 1*s.* 6*d.* is derived. This is carried to the general account and applied to the same purposes as the income derived from the founder's endowment.

- b. A sum of 200*l.* per annum contributed for five years in aid of the chemistry department.

A sum of 150*l.* per annum contributed for a period, not exceeding four years, in aid of the mathematics department.

- c. The engineering instruction fund of 9,472*l.* 15*s.*, producing a gross yearly income of 378*l.* 18*s.* 2*d.*, which is applied to the payment of the salary of the Professor of Engineering, and of the expenses of his department.

- d. The Ashbury endowment of 5,000*l.*, subject to a payment of 1,000*l.* hereafter to purposes unconnected with the College, as prescribed by the donor. The yearly income is 400*l.*, but the income, except 50*l.* per annum offered for two scholarships in engineering, will not be available for two or three years. It will then be applied in payment of scholarships in engineering, and for other purposes connected with that department.

- e. A further contribution of varying amount, say about 100*l.* per annum for five years, also in aid of the engineering department.

- f. The Dalton fund of 4,125*l.*, producing an income of 165*l.* per annum, applied to

Two scholarships of 50*l.* each per annum in chemistry.

Two ditto of 25*l.* each per annum in mathematics and natural philosophy.

One annual prize of 15*l.* in natural history.

Out of the funds accruing from scholarships not awarded, entrance exhibitions in chemistry and mathematics have been given for many years past.

3. The fees paid by students for science classes in the present session amount to 1,946*l.* 8*s.* 5*d.*, out of which 1,463*l.* 14*s.* 11*d.* is payable to the professors of those classes, and the balance, 482*l.* 13*s.* 6*d.*, is applied to the general expenses of the College.

22d March 1871.

- A.—RETURN OF NUMBER OF SCIENCE STUDENTS attending in 1870–1, with an estimate of the average fees paid by each, and the cost of each to the College:—

Session 1870–1.

Art students	-	150
Science „	-	111
		261 day students.

No. of STUDENTS in the several SCIENCE CLASSES.

Mathematics	{	Lower junior, A. division	45
		Do. B. „	38
		Higher junior	34
		Lower senior	13
Natural Philosophy	{	Higher senior	4
		Experimental course, mechanics	91
		Do. physics	45
		Mathematical course, junior	9
Engineering	{	Do. senior	4
		Physical laboratory	3
		Mechanical, junior	19
		Do. senior	4
	{	Civil, junior	15
		Do. senior	2



*J. G. Greenwood, Esq., B.A.*  
31 March 1871.

Chemistry	Geometrical and Mechanical Drawing	-	-	24
	Lectures, junior class	-	-	118
	"    senior class	-	-	29
	"    organic, extended	-	-	8
	"    course	-	-	10
	"    technology	-	-	6
Natural History	"    calculations	-	-	25
	"    analytical	-	-	60
	Laboratory	-	-	13
	Analytical physiology and	-	-	11
	zoology	-	-	9
	Geology	-	-	
	Botany	-	-	

**B.—AMOUNT PAID by DAY STUDENTS in SCIENCE CLASSES:—**

	£	s.	d.
Mathematics	346	3	0
	2		
Natural philosophy	373	17	5
Engineering and mechanical drawing	155	16	5
Chemistry, lectures	474	19	9
"    laboratory	703	3	0
	1,178	2	9
Natural history	65	10	4
	£1,946	8	5

Of this - 1,463 14 11 is paid to professors,  
and - 482 13 6 is retained by the College.

£1,946 8 5

**Average fees paid by each science student:—**

£1,946 8 5 = 17 10 8

**C.—ESTIMATE of the COST to the ENDOWMENT FUND of the SCIENCE CLASSES:—**

	£	s.	d.
Professors' salaries	1,693	4	5
Assistants' "	425	0	0
Servants' wages	143	0	0
Working expenses of science department	633	10	11
Half of general expenses, not including any of the above items	666	1	1
	3,560	16	5
Less College share of science fees	482	13	6
	£3,078	2	11

**Average cost of each science student:—**

£3,078 2 11 = 27 14 8

**D.—ESTIMATE of the COST to the ENDOWMENT FUND of the ARTS DEPARTMENT:—**

	£	s.	d.
Professors' salaries	1,500	0	0
Assistants' "	50	0	0
Half of general expenses of establishment	666	1	1
	2,216	1	1
Less College share of arts fees	466	18	4
	£1,749	2	9

**Average cost of each arts student:—**

£1,749 2 9 = 11 13 3

**Average fees paid by arts students:—**

£1,400 15 0 = 9 6 2

**E.—FIXED SALARIES PAID to PROFESSORS and ASSISTANT LECTURERS:—**

Professors.			
ARTS.		£	
Professor of Greek	- - - - -	350	
Professor of Latin	- - - - -	250	
Professor of English language and literature	- - - - -	300	
Professor of ancient and modern history	- - - - -	175	
Professor of mathematics (half)	- - - - -	250	
Professor of logic and mental and moral philosophy	- - - - -	75	
Professor of political economy	- - - - -	100	
Professor of jurisprudence and law	- - - - -		
Professor of modern languages	- - - - -		
		1,500	
			1,625
Assistant Lecturers.			
Mathematics	- - - - -	100	
Mathematics (transferred to arts).	- - - - -		100
"    for evening lectures	- - - - -		100
Natural philosophy	- - - - -		90
Engineering	- - - - -		100
Chemistry, senior assistant	- - - - -		80
"    junior	- - - - -		5
Natural history, occasional	- - - - -		
		100	475
		£1,600	£2,100

7259. Mathematics is divided between the literature side and the science side, is it not?—Yes, mathematics being indispensable on the one hand to the arts students, and also indispensable to the science students, we thought it was fair to divide the fees payable to that chair between the two sides of the College. On the other hand, we of course set down chemistry and natural philosophy, of which subject we have two professors, civil and mechanical engineering, and natural history, to science; we set down Greek, Latin, English, and history, logic, political economy, jurisprudence, and modern languages, to the arts side, although it might be fairly urged that modern languages are as necessary to the student of science, as they are to the student of literature. I think we have thrown on the literature side almost all that was doubtful and that might fairly be claimed on both sides, so that the

resulting figures which I have read might have been made stronger in the way of showing that the science side receives on the whole much more than one half of our income. Having said what is paid to the science professors and their assistants from the endowment fund, I proceed to state what is paid to them as their share of the fees paid by the students. The gross amount paid by the students in the present session in the day classes is 3,350*l.* Of that the College retains 950*l.*, leaving 2,400*l.* to be divided between the professors of arts and science respectively. Of that sum the professors on the science side receive 1,463*l.* and the arts professors receive about 950*l.* Then another comparison is this, namely, of the nett cost to the endowment fund of each science student and of each arts student respectively; and this we get at in the following



way, although, of course, there is an element of uncertainty in the comparison. We take the whole 261 students, and we go through a careful examination of the list, and try to determine how many of them may be called science students and how many literature or non-science students, and we find, by the best means of comparison that we have, that 111 should be classed as science students and 150 as non-science students. We have taken the total sums spent in the science and non-science sides respectively, and subtracting from those two totals the income derived from fees by the College at present, the residuum leaves us the nett cost to the institution of the two sides respectively. We then divide the two residue sums by 111 in the one case, and 150 in the other case, and the result shows that each science student costs the endowment 27*l.* 15*s.*, and each arts student, or non-science student, costs the endowment 11*l.* 13*s.*, and that, although, from the nature of the case, the fees paid by the science men are much heavier than those paid by the non-science men. Every science student on the average pays 17*l.* 10*s.*, and every arts student pays 9*l.* 7*s.*, so that while the science men pay on the average twice as much as the non-science men, they yet cause a nett expenditure to the endowment of 27*l.* 15*s.* against a nett expenditure of 11*l.* 13*s.* in the other case. Of course the addition of the two sums would give about 45*l.* as the gross cost of each science man against, in the other case, about 20*l.*

7260. And do those science fees include all the cost of laboratory instruction?—Yes. One of the papers which I have handed in contains details of the fees paid by the students. In pure mathematics they amount to 34*l.*, natural philosophy 373*l.*, engineering and mechanical drawing 155*l.*, chemistry lectures 475*l.*, and laboratory 703*l.*, making the total of the chemistry fees 1,178*l.*, and natural history 65*l.* 10*s.*, making a total of almost 2,000*l.*, in fees, paid by the science side of the College.

7261. Do you consider the income, whether derived from endowment or from fees, adequate to meet the cost of the instruction?—By no means. If I understand the question to mean whether an effort on our part to teach the subjects as they should be taught would call for further expenditure, I would say with great confidence that even as it is our Science Department may be said to be starved. We have not the proper number of assistants, for example, nor of professors, nor (although I say so with some reluctance) do I think that the professors are adequately paid for the amount of time and work that they bestow upon the instruction.

7262. Is the scale of fees as high as you think it would be safe to place it?—I cannot but think that it is. I may first of all remark that, in comparison with other institutions of the same kind, our fees are much lower than the fees at University College; perhaps quite one half lower. At King's College the same statement would hold good. At Glasgow the fees, I think, are about the same as ours. I should like to put before the Commission the following interesting comparison. I find, by looking at the last report of University College, that, our scale of fees being about one half lower than that which obtains there, the average payment made by our students is almost the same as the average payment made by the students of University College. The total number of students in that College last year was 291, and the total number of students at our College this year is 261, so that the numbers are sufficiently near to allow of a fair comparison. The 291 students in the Arts Faculty of University College (which is equivalent to literature and science with us) paid last year 4,000*l.*, or about 14*l.* for each student. In Owens College in the current year the 261 students paid 3,350*l.*, or almost exactly 13*l.* a man. Those fees being twice as high at University College, the average payment by each man is almost the same as with us, 14*l.* against 13*l.*; and the conclusion which one must draw from those figures is, that anything like an important increase of

our fees would lead to a large reduction in the number of classes attended by each student, and to a falling off in the work done by the College and in the benefit accruing to the public. There may, of course, be modifying circumstances which would tend to lessen the force of those figures, but at the same time the discrepancy is very great when a scale of fees twice as high produces almost exactly the same amount. Therefore, it is impossible not to suppose that an important alteration in fees would lead to a falling off in the number of classes attended.

7263. (*Dr. Sharpey.*) Can you say what is the actual fee, say for Greek?—The Owens College fee is 2½ guineas for the session of 35 weeks, three lectures being given weekly, and that, I ought to say, is a somewhat lower fee than is paid in corresponding classes. The average fee paid by our men is 6*d.* or 7*d.* per lecture. I mean that, supposing there are three lectures in a given class weekly, 1*s.* 9*d.* per week would be the sum paid by each student, and if you multiply that by 35, it will give the actual sessional fee. It is a sliding scale, the unit being slightly less as the number of weekly lectures increases; but still, allowing for the sliding scale, that is about the average payment of the students, 6*d.* or 7*d.* per lecture.

7264. (*Chairman.*) Can you supply the Commission with some details as to the gradual growth of your Science Department?—I may state that when the College was first opened the classes met in what was simply a large house, a convenient house purchased by the Trustees, as giving on the whole a fair provision for the first wants. I ought to add also that Mr. Owens' will left us no power to employ any portion of his estate for the purchase or erection of buildings. It was, therefore, determined to buy a large house, and to take time to see what should be done ultimately. One of the Trustees, a friend of Mr. Owens, paid the cost of that house, and made a present of the title deeds to the trust; and something like 2,000*l.* was at once spent upon the building of a good laboratory, under Dr. Frankland's supervision. However, in about ten years, or less than ten years, we were outgrowing the narrow limits which we had assigned to ourselves, and it began to be necessary for us to ask the public of Manchester to find us funds for either an enlargement or the erection of new buildings. This necessity arose in the first instance rather from the science than from the arts side, because a professor of Greek or Latin wants nothing more than a class room of certain dimensions, a black board, a piece of chalk, and a library, and he is fully furnished; whereas, in almost all the science departments room is wanted for laboratory purposes, for illustrative lectures, for museums, and for a number of other expensive demands. In 1859 I think it was that we first established a separate chair of natural philosophy. Professor Clifton, now of Oxford, was the first professor appointed, and under his energetic direction that department soon assumed important proportions, and demanded enlarged accommodation. Then, some few years after, the engineers of Manchester invited us to found an engineering professorship, they finding the funds for the foundation themselves. That immediately led to the same necessity; and although the arts classes had also grown rapidly, yet the problem of finding room for them was much more easily met than that of finding room for the corresponding classes on the science side. Within a year only we have found it necessary to cut our natural philosophy professorship in two, and to appoint a coadjutor professor, so rapidly was the demand for teaching power in that particular subject growing. Professor Clifton was followed by Professor Jack, who raised the classes even beyond the point of success which Professor Clifton attained, and now, within the course of 12 months, Doctor Balfour Stewart having taken Professor Jack's place, it was found we could not with justice to that department even wait until we entered on our new buildings, but we were obliged in our present buildings, at the risk of keeping the department down, to

J. G. Greenwood, Esq., B.A.

31 March 1871.



J. G. Greenwood, Esq., B.A.

31 March 1871.

make provision for a physical laboratory, and to appoint a second or coadjutor professor. That appointment has been made, happily for us, for Doctor Balfour Stewart's unfortunate accident in November would have robbed us of our professor altogether, unless we had given him a colleague. Thus, even at the present moment, in what is nothing more than a large house, we have contrived to fit up a physical laboratory of some size, and have appointed a skilled assistant, so that we have now two professors and an assistant in natural philosophy; we have a professor of chemistry and two skilled assistants; we have a professor of engineering and one skilled assistant; but we have at present only one professor of natural history, who takes geology, zoology, and botany, and that is a department which I think most loudly calls for immediate attention and development. But further, we feel that we ought to fit up a separate professor of architecture, and the arts of construction, and at present the surveying branch of engineering is necessarily done in a somewhat inadequate way, owing to the want of larger teaching power. I might also say that natural philosophy with us includes really three distinct branches; it means the mathematical applications of the subject, which are wholly cut off by us from the professor of pure mathematics; and it means experimental mechanics, and experimental physics, and that, too, in all its branches. Thus it will be plain that it is only by making the course extend over two years, or, perhaps, even two and a half years, the professor can pretend to cover the whole range which belongs to him. When we have, as we hope to have soon, when Professor Stewart returns to us, the two professors in full working order, we shall probably be able to cover the whole ground each year.

7265. Did the demand for increased accommodation lead to that movement known as the Owens College Extension movement?—Yes.

7266. What are the prospects of that movement at present?—That movement dated from the year 1866. A paper was drawn up by the Professors at the request of the Trustees, which contained a statement of the extensions most urgently called for. Those extensions, so far as the science side of the College goes, were as follows:—First, a chair of civil and mechanical engineering, and, if possible, a chair of architecture; second, a chair of applied geology and mining; third, a chair of astronomy and meteorology; then the appropriation, fourthly, of sums for the extension and maintenance of the chemistry, physics, and natural history appliances, and the establishment of museums and other collections in these and in the engineering departments; and, lastly, the introduction, if possible, of a school of medicine. Elaborate statements on these subjects were laid before a meeting in the Manchester Town Hall. This paper A, which I beg leave to hand in, contains the recommendations of the professors as to the extensions, and paper B, which I will also hand in, is the substance of a statement laid before Mr. Disraeli's Government in 1868:—

#### A.—OWENS COLLEGE.

##### SUGGESTIONS FOR ITS EXTENSION, &c.

The Principal and Professors of Owens College, understanding that there is a prospect of immediate action being taken by the Trustees in order to obtain new college buildings, desire respectfully to lay before them the opinions which, after mature consideration, have been formed by the Professors on this subject.

In a document presented by the Professors in March 1866, and adopted and printed by the Trustees, it has been made clear that the authorities of the College contemplate not merely the erection of new buildings in a better site, but also a very considerable extension of the scheme of studies pursued. In the following paper we proceed to suggest in greater detail what, in our opinion, the character of that extension should be.

I. We conceive that the object of the College may be fitly defined as being "to furnish to the South Lancashire district the highest general education, leading to degrees in

"arts and science, and the special training required for professional life."

II. The general instruction at present given in Owens College falls under two departments—that of general literature and science, and that of theoretical and applied science. The department of general literature and science (arts course) comprises Greek, Latin, Oriental languages, English language and literature, modern languages, ancient and modern history, logic, mental and moral philosophy, political economy, and mathematics. The department of theoretical and applied science (science course) comprises mathematics, natural philosophy, chemistry, zoology, botany, and geology.

The nucleus of a school of law exists in a professorship of jurisprudence.

III. In the department of general literature and science, we find no important subject entirely unrepresented; but we are of opinion that on some points a re-arrangement is called for. For instance: at the present time one person is charged with the Principalship and the Professorship of two important subjects—Greek and Latin. It would be desirable, with a view to the thoroughly efficient teaching of the classical subjects, that the chair of classics should be divided into two—one of Greek, the other of Latin and Comparative Grammar.

IV. In the Department of Theoretical and Applied Science, the following important branches of Scientific and Professional study are entirely unrepresented:

##### 1.—CIVIL AND MECHANICAL ENGINEERING.

In accordance with the views embodied in a paper laid before the Trustees in April 1863, we consider that at least one Professor should be appointed to take charge of these subjects. We rejoice to learn that steps are already in progress for accomplishing this object.

##### 2.—ASTRONOMY AND METEOROLOGY.

A Professor of these subjects should be appointed, and an observatory should be connected with the Chair. The interest taken in the study of astronomy in this district induces us to believe that the amount required in order to establish the Chair might readily be raised among the friends of the science, as in the case of the Engineering Fund.

3.—In view of the importance of mining industry in the district of South Lancashire and Yorkshire, a Chair of Applied Geology and Mining should be established.

V. It would be necessary to set aside a considerable sum for the extension and maintenance of the chemical, physical, and natural history departments. We understand that negotiations have already been entered into between the Trustees and the Council of the Natural History Society, with a view to some connexion between them and Owens College. By this means one of our most pressing wants might be effectually remedied—that of a museum in which the students could readily examine specimens illustrating the teaching of the Professor of Natural History.

A further sum should be appropriated for the extension and regular maintenance of the library.

VI. In our judgment, it would be of great advantage to the College to attach to it an efficient medical school.\* It would not, however, we believe, be desirable to do so, unless due facilities could be secured in connexion with the infirmary for the efficient clinical instruction of the students.

We offer this opinion to the Trustees under the impression that the present authorities of the Manchester Royal School of Medicine are willing to agree to arrangements by which the proposed Medical School in connexion with Owens College should be amalgamated with the Royal School of Medicine.

We have already stated our opinion (in a Report on this subject in February 1866) that it would be necessary to set aside a considerable sum of money for the endowment of one or more chairs.

VII.—Having carefully considered the want, which has been long felt, of some provision for the residence of students coming from a distance, we are of opinion that it is expedient that such provision for residence, under fitting superintendence, should exist. In view of all the difficulties attending this question, we believe that the want would be most effectually met by the foundation of one or more halls of residence in proximity to the College, but on separate trusts and under wholly independent management, subject only to such general superintendence

\* Professor Williamson does not concur in this recommendation (§ IV.)



on the part of the Principal, as should be necessary for the maintenance of the general discipline of the College.

VIII. We have already considered the details necessary in order to carry into effect these several recommendations, and we shall be ready at any time to communicate concerning them with the Trustees. We have estimated that the New Buildings may be erected and the proposed extensions, with the exception of the engineering school and the halls of residence, accomplished for the sum of 100,000*l*.

(Signed)

J. G. GREENWOOD, Principal and Professor of Classics.  
A. W. WARD, Professor of English and History.  
T. BARKER, Professor of Mathematics.  
W. JACK, Professor of Natural Philosophy.  
W. S. JEVONS, Professor of Logic, &c., and Political Economy.  
R. C. CHRISTIE, Professor of Jurisprudence.  
H. E. ROSCOE, Professor of Chemistry.  
W. C. WILLIAMSON, Professor of Natural History.  
T. THEODORES, Professor of Oriental and Modern Languages.

OWENS COLLEGE,  
14th December 1866.

#### B.—OWENS COLLEGE EXTENSION.

1. Owens College was founded by the bequest of Mr. John Owens, merchant, of Manchester, who, dying in 1846, bequeathed the larger part of his property, amounting to nearly 100,000*l*., to Trustees, "to found an institution for providing or aiding the means of instructing or improving young persons of the male sex (and being of an age not less than 14 years) in such branches of learning and science as were then and might be thereafter usually taught in the English Universities."

2. The government of the College is in the hands of 14 Trustees, appointed under the will of the founder. The work of instruction, the maintenance of discipline, and the ordinary executive, subject to the general control of the Trustees, are committed by them to the Principal and Professors, nine in number, teaching Greek and Latin (including the Greek Testament), Hebrew and Arabic, English Language and Literature, French and German, History, Mathematics, Natural Philosophy, Logic and Mental and Moral Philosophy, Political Economy, Jurisprudence, Chemistry, and Natural History.

In the will of the Founder power was expressly given to the Trustees to apply for a charter of incorporation from the Crown. They have for some time been of opinion that it will be expedient to make such application in connexion with the proposed extension and re-constitution of the College.

3. The College was opened in March 1851. The number of students in the ordinary day classes in the first session was 62, and in the present session is 172.

In 1852 evening classes were introduced, and the number of students in these classes is now 323.

Of the students in the ordinary day classes 32 are above 14 and under 16 years of age; 58 are above 16 and under 18; 36 are above 18 and under 21; and 46 are above 21 years of age. The age of the evening students is not registered, but the average is of course considerably higher. The great majority of the members of the evening classes are young men employed during the day in warehouses and manufactories; not a few are teachers in primary or other schools.

A considerable number of the students, both in the day and evening classes, come from the neighbouring large towns of Lancashire, Yorkshire, and Cheshire.

4. The work of the College is carried on in a large house, in a central but obscure part of the city. The class rooms are now, and have for some years been, too few in number, and many of them are inconveniently crowded. In short, the buildings, with the exception of an excellent chemical laboratory, supply scarcely any of the special provisions demanded by a College.

5. The need of new buildings has thus been for some time extreme. Accordingly, about 12 months ago, the Trustees and Professors, supported by some of the most influential inhabitants of Manchester and the neighbouring towns, made an appeal to the public for funds wherewith (1) to purchase a site and erect suitable college buildings, and (2) to found new professorships, and to promote the efficiency of those already founded by a better provision of the necessary appliances. For these two objects it was considered that 150,000*l*. would be necessary. The scheme was adopted in its general features, and a committee was appointed to carry it into effect.

26060.

6. Mr. Owens defined the studies to be pursued in his College as those which were usually taught in the English Universities, and this injunction has been followed, both as to method and as to subject matter. Equal rank has been assigned to what may be called the old and the new studies, —those in arts and literature, and those in applied and experimental science.

But while due precautions were thus taken against a one-sided culture in either direction, it was to be expected that the College, if it possessed any vitality, would have a characteristic development of its own; and in Manchester, the heart of the manufacturing district, it was almost inevitable that this development should be as a school of science.

7. A conviction is now widely spread that there should be in England, as in France and Germany, colleges giving instruction, at once complete and thorough, in all the leading branches of applied and experimental science. It is felt that what is wanted is the foundation, not of workshops for teaching manufacturing processes, but of schools of science (1) in which those who are to direct the industry of the country may receive thorough training in Mathematics and the principles of Physical Science; (2) in which those artisans who have proved themselves to be possessed of superior parts may, by acquiring a knowledge of science, fit themselves to fill more important positions; and (3) in which competent teachers may be trained, both for the higher posts and for teaching soundly the rudiments of science in primary and secondary schools.

8. It is evident that no place is more fitting than Manchester to be the seat of such a school of science; and if it be a matter of almost national importance that such districts as that of which Manchester is the centre should possess a college of these pretensions, the effort now making to enlarge and (so to say) re-found Owens College, which is already doing a considerable amount of satisfactory work in this very direction, affords an opportunity of, at once and with exceptional ease, supplying the need in the place where it is felt the most.

9. It is proper that evidence should be offered that Owens College is fitted to be the channel of such an extended training in science.

Owens College is affiliated to the University of London, the rigour of whose examinations is matter of notoriety, and which is the only University in the kingdom which gives special degrees in science. The success which candidates from Owens College have had in the science examinations of the University is conspicuous.

At the First B. Sc. Examination, in July last, of 17 who passed, 4 were of Owens College (three of them in the first division), and in the succeeding Honours Examinations, its students gained the first place in Mathematics and Mechanical Philosophy; the first, second, and fourth places in Chemistry and Natural Philosophy; and the first and third places in Biology.

Again, in the Second or final B. Sc. Examination, in October, out of 10 who passed, 3 were of Owens College (one in the first division), and at the succeeding Honours Examinations, its students won the first and third places in Chemistry, the first in Botany, and the second and fourth in Geology. Examinations of the University for degrees in Arts and Science are held in Owens College simultaneously with those in London.

10. Numerous proofs have been given of the estimation in which the College is held by the inhabitants of Manchester and its neighbourhood, as will appear from the following list of benefactions:—

"The Auxiliary Fund," consisting of donations from 118 merchants and others, made about the year 1852, for the erection of a chemical laboratory, the formation of a library, and generally in aid of Mr. Owens' bequest	£9,610
Land and buildings, the gift of the late George Faulkner, Esq., originally valued at	4,500
The "Victoria Scholarship" [Classics]	500
The "Wellington Scholarship" [Greek Testament]	500
The "Dalton Memorial Fund" for Scholarships in Science	4,125
The "Shuttleworth Scholarship" [Political Economy]	1,250
The "Shakespeare Memorial Fund," for a Scholarship in the English Language and Literature	1,071
The "Cobden Memorial Fund," for the further endowment of the Chair of Political Economy, and for prizes	1,966
The "Grammar School Scholarships"	1,060
	£24,582



*J. G. Greenwood, Esq., B.A.*  
 31 March 1871.

11. The funds in the possession of the College amount, therefore, to about 120,000*l.*, yielding a yearly income of about 3,700*l.*; and by the addition of students' fees (about 2,300*l.*) the total income of the College is raised to 6,000*l.*

To provide suitable buildings, and to make the desired extension, it is proposed to raise a fund of 150,000*l.* Of this sum, it is calculated that two-thirds will be required for land and buildings, including Chemical and Physical Laboratories, Museum, &c., and one-third for the endowment of new Professorships and the maintenance of the Library and the Scientific Departments.

No general canvass for funds in support of the extension movement has yet been undertaken. Notwithstanding—(1) the sum of 9,000*l.* has been contributed by the engineering profession towards the endowment of an Engineering Department; (2) the Manchester Natural History Society has, under certain conditions, made over on trust to the College its large and valuable collections, and property estimated to be worth 13,000*l.*; (3) from the general public promises of 31,000*l.* have been received. These sums amount to 53,000*l.*, which, with the estimated value of the land and buildings now occupied by the College (6,000*l.*), gives a total of 59,000*l.*

12. Application is most respectfully made to the Government for aid, on the following grounds:—

1. That the North of England stands in especial need of such a College as has been described, and that Manchester would be its natural seat.
2. That Owens College contains the nucleus of a Science School of the first order.
3. That the presence in Owens College of a Faculty of Arts by the side of the Faculty of Science adds greatly to its value, even as a School of Science.
5. That as the College is already endowed and in active operation, and as towards its extension large sums have been promised, and other large sums may be confidently anticipated from the liberality of the public of Lancashire and the neighbouring counties, Government can in Manchester secure at once, and by a relatively small expenditure, what could only be obtained elsewhere by a much larger outlay and after the lapse of several years.

THOMAS ASHTON, *Chairman*  
 OLIVER HEYWOOD, *Treasurer*  
 WM. H. HOULDSWORTH, *Hon. Secretary*  
 ALFRED NEILD, *Chairman of the Trustees, Owens College.*  
 J. G. GREENWOOD, *Principal of Owens College.*

Owens College, Manchester,  
 24th February 1868.

These papers or corresponding papers were laid before a meeting held in the Manchester Town Hall in 1867, the Mayor being in the chair, and a number of the most influential citizens of Manchester taking part in the meeting. The meeting approved of the proposals, and adopted the statements, and appointed a Committee to carry them into effect, declaring, by a resolution, that it was expedient to raise the sum of 100,000*l.*, or, if possible, 150,000*l.*, for carrying into effect the objects proposed. This paper, which I will hand in, B<sup>2</sup>, contains an account of the meeting which was held in pursuance of our proposals:—

## B<sup>2</sup>.—OWENS COLLEGE EXTENSION.

Owens College was founded by the munificent bequest of Mr. John Owens, merchant, of Manchester, who bequeathed the bulk of his property to Trustees, to found "an institution for providing or aiding the means of instructing and improving young persons of the male sex (and being of an age not less than 14 years) in such branches of learning and science as were then and might be thereafter usually taught in the English Universities."

The College was opened on the 12th of March 1851. The number of students in the ordinary day classes in the first session was 62; in the present session it is 110; and the average number for the last five years has been 115. In 1852–53 evening classes were started, in which instruction is given in almost all the subjects taught in the day classes. The number of evening students has increased from 28 in 1852–53 to 279 in 1866–67, and the average number for the last five years has been 295. It thus appears that the total number of persons taught in the College has averaged 400 during the last five sessions. The number of day classes held has increased from 15 in 1852 to 32 in the present year, and the number of evening classes from 2 to 25.

From its foundation, Owens College has been affiliated to the University of London. More than 130 of its students have matriculated in the University, and about one-half of these have proceeded to the higher examinations for degrees.

It would probably be found that in no institution of the kind in the kingdom are so many persons under instruction in so confined a space. The class-rooms are too few in number, some of them are unduly crowded, and others are quite unfit for the use to which they are put.

It is, then, not too much to affirm that the utmost measure of success attainable in the present buildings has been reached. The Trustees have no power to spend any portion of the original endowment in the purchase of land or the erection of buildings. Unless ampler and more appropriate accommodation is provided for the College, future sessions may witness a decline as steady as its growth has been; for, in the early years of such institutions, not to go forward is to go back.

The erection of new buildings is not, however, all that is needed to enable Owens College to fulfil the object of its foundation. The proper function of the College may be defined as being to furnish the highest general education, leading to degrees in arts and science, and the special training required for professional and mercantile life. To accomplish this, a very considerable extension of the scheme of studies pursued is called for. Nor can there be a doubt what the prevailing character of this extension should be. Due provision being made for the pursuit of classics and mathematics, and of the other branches of what may be called the older university studies, it is obvious that the special characteristics of a college for the manufacturing districts should be the study of experimental and applied science.

The College already possesses professorships of Greek and Latin (including the Greek Testament), Hebrew and Arabic, English language and literature, French and German, history, mathematics, natural philosophy, logic, &c., political economy, jurisprudence, chemistry, and natural history. To these it is proposed to add—

1. A separate professorship of Latin and comparative grammar.
2. At least one professorship of engineering; and, if possible, of surveying and architecture.
3. A professorship of applied geology and mining.
4. A professorship of astronomy and meteorology.

It would be necessary, further, to provide most of these chairs with all the apparatus for complete and successful study; to set aside considerable sums for the extension and regular maintenance of the library, and of the physical and natural history departments; and, above all, to place the chemical department in a position of efficiency worthy of the present state of the science, and of its importance in relation to the interests of this district.

With these additions and extensions, the College would begin to assume the proportions and to possess the substantial advantages of a university for the manufacturing districts. The experience of Glasgow proves that academical institutions may flourish in the heart of a mercantile and manufacturing society; and the munificence with which a subscription for erecting new University buildings has been recently commenced shows not more the liberality of the people of Glasgow than their sense of the benefits which the University has conferred upon their city.

The substance of the above statement was laid before a meeting held in the Town Hall, Manchester, on the 1st February, 1867, His Worship the Mayor in the chair; when the following resolutions were passed:—

Proposed by the Very Rev. the Dean of Manchester, and seconded by Mr. Oliver Heywood:—

"That this meeting, having heard with satisfaction the statements of the Trustees and Professors of Owens College, as to its constitution, operations, and present success, and the suggestions offered for supplying the requirements of the College, and for rendering it on an extended basis, in effect, the local University of Lancashire and the neighbouring counties, is of opinion that the time has come for the public of the district to unite for the purpose of developing the College on a more comprehensive scale, and in appropriate and convenient buildings."

Proposed by Mr. Thomas Bazley, M.P., seconded by Mr. Thomas Ashton, and supported by Sir Elkanah Armitage, Knt.:—

"That the Trustees and Professors of Owens College, and the following gentlemen (the list contains the names of sixty-nine gentlemen), with power to add to their number, constitute a committee for raising a fund which it is desir-



"able should not be less than 100,000*l.*, or, if possible, 150,000*l.*, for the purpose of carrying into effect the proposed system of extension."

Proposed by Mr. W. R. Callender, sen., and seconded by Mr. John Platt, M.P.:—

"That an executive committee be appointed, consisting of the following gentlemen (with power to add to their number):—

Thomas Ashton, Esq., Chairman.

Oliver Heywood, Esq., Treasurer.

Benjamin Armitage, Esq.,

Charles F. Beyer, Esq.,

W. R. Callender, jun., Esq.,

Richard Johnson, Esq.,

John L. Kennedy, Esq.,

Sigismund J. Stern, Esq.,

with Principal Greenwood,

Professor Christie,

Professor Roscoe,

and six Trustees of the College. (The following gentlemen were accordingly elected by the Trustees out of their body):

Robert D. Darbshire, Esq.,

Murray Gladstone, Esq.,

W. H. Houldsworth, Esq.,

Alfred Neild, Esq.,

John Robinson, Esq.,

John Edward Taylor, Esq.

And that such committee have power to determine on and carry out measures for raising the required fund, and that they be requested to prepare a scheme of such extent as may be deemed desirable and warranted by the funds subscribed, such scheme to include the recommendation of a site and of plans of buildings, the endowment of professorships, and other means of imparting instruction and encouraging study in the various departments of learning and liberal arts, and of science and its applications. The committee to report from time to time to the subscribers."

The executive committee confidently appeal to the public of Manchester and of the manufacturing districts for funds to enable them to purchase a suitable site, and to erect commodious and appropriate buildings, in which the actual work of the College may be more efficiently carried on and such additions made as have been indicated above.

THOS. ASHTON, Chairman of the Executive Committee.

OLIVER HEYWOOD, Treasurer.

J. G. GREENWOOD,

W. H. HOULDSWORTH, } Hon. Secretaries.

Owens Collège, March 1st, 1867.

The committee which was appointed at that meeting immediately proceeded to its task. That task consisted in fact of three distinct branches—to raise the funds, to prepare the new scheme of constitution, and to obtain a charter from the Crown giving effect to it, and (which is most important with reference to the inquiry of the Commission) the consideration of the several schemes for extension. The efforts of the committee in the matter of funds have been, I think I may say, very successful. In the face of great commercial depression they have raised by subscription about 77,500*l.* That includes, I ought to say, a general building fund, and a special endowment fund, which has only lately been opened, and to which we attach the greatest importance. Then there is the special engineering fund, amounting to 13,500*l.*; the value of the present site and buildings is supposed to be not less than 7,000*l.*; and another piece of property which I will speak of presently, consisting of the property of the Manchester Natural History Society made over on conditions to us, is supposed to be worth not less than 13,000*l.*, when all the claims on it are paid. The total of those four sums amounts to 111,000*l.*, and that represents the amount of money at present available for buildings and for extension. There is, however, still a large sum immediately needed. Not less than 30,000*l.* is required for the completion of the pile of buildings actually commenced, and we shall need a certain addition to our annual income to enable us to meet the increased working expenses of the larger buildings. With regard to the gift of the Museum and the property attached to the Museum, which has been spoken of, I ought to say that that is only a contingent gift, contingent on this, that we erect on our new site an adequate building for the purposes of the museum and lecture rooms in connexion with the department, and the lowest estimate that Mr. Waterhouse has given us of the cost of that building is 15,000*l.* Therefore, after deducting 5,000*l.*, which is the greatest sum that

we are allowed to use from the property of the society, there still remain 10,000*l.* to be raised by us for the purpose of the building itself; and we, therefore, cannot enter into possession of the museum till we have 10,000*l.* in hand. That is not included in the 30,000*l.* of which I spoke as being needed for our building purposes. I may say that 40,000*l.* are needed by us for the buildings which must be raised, and which we have actually commenced. We have paid for the land 30,000*l.*, and the estimate of the building is between 50,000*l.* and 60,000*l.*, not including the museum. I will hand in here, in connexion with that statement, the last report of the Extension Committee, with a list of subscriptions appended to it, and the result of those figures is to show that we have raised 111,000*l.* as the total sum which we now have to spend. The list of the subscriptions consists of three parts, the general or building fund, the special engineering fund, and the endowment fund, which consists of large donations, most of them for the endowment of some of the special branches, and some for the general work of the Collège.

#### OWENS COLLEGE EXTENSION.

##### EXECUTIVE COMMITTEE.

CHAIRMAN: THOS. ASHTON, Esq.

TREASURER: OLIVER HEYWOOD, Esq.

BENJAMIN ARMITAGE, Esq.

CHAS. F. BEYER, Esq.

W. R. CALLENDER, Jun., Esq.

R. C. CHRISTIE, M.A.

R. D. DARBISHIRE, Esq., B.A.

MURRAY GLADSTONE, Esq.

Prof. J. G. GREENWOOD, B.A.

W. H. HOULDSWORTH, Esq.

RICHARD JOHNSON, Esq.

J. P. JOULE, Esq., LL.D., F.R.S.

JOHN L. KENNEDY, Esq.

ALFRED NEILD, Esq.

HERBERT PHILIPS, Esq.

JOHN ROBINSON, Esq.

Prof. H. E. ROSCOE, Ph. D., F.R.S.

S. J. STERN, Esq.

J. E. TAYLOR, Esq.

JOSEPH THOMPSON, Esq.

Sir J. WHITWORTH, Bart., D.C.L., F.R.S.

THIRD REPORT OF THE EXECUTIVE COMMITTEE,  
Presented to a Meeting of the Subscribers, held in the  
Town Hall, on Friday, 22nd July 1870.

##### 1st.—As to the Extension Fund.

Since the last meeting of the subscribers the state of trade has rendered any active prosecution of the canvass for subscriptions undesirable; nevertheless, there has been added to the extension fund, 12,625*l.* 9*s.* 10*d.*, including a fund to increase the endowment of the Collège, which amounts to 9,500*l.*, 1,000*l.* of which is conditional upon a given amount being subscribed.

The entire extension fund up to date, including the value of the Quay Street site, amounts to 102,030*l.* 12*s.* 2*d.*; of this amount 53,945*l.* 15*s.* 4*d.*, in addition to the engineering fund of 13,505*l.*, has been paid into the bank, and an account of the receipts and expenditure of the Executive Committee will be submitted to the meeting.

##### 2nd.—As to the New Building.

The last meeting of the subscribers approved the building plans which were then submitted, and authorised the Executive Committee to proceed with the erection of the new college buildings.

The Committee have continued to give their unremitting attention to the details of the plans prepared by Mr. Waterhouse, and to revise them from time to time with their accumulating experience, and they are happy to be able to announce that the foundations for the new building are now being laid, and that the contracts for the superstructure will be immediately let.

##### 3rd.—As to the Owens Extension Collège (Manchester) Act.

The last meeting of subscribers authorized the Executive Committee to prosecute their application for a bill to Parliament based upon the new constitution then adopted. The Committee gave special and mature consideration to the preparation of the bill, and they have the satisfaction to report that it received the Royal Assent on the 4th July 1870. In the passage of the bill through Parliament they received the cordial assistance of the Right Hon. Earl de Grey and

J. G. Greenwood, Esq., B.A.

31 March 1871.



*J. G. Greenwood, Esq., B.A.*

31 March 1871.

Ripon, President, and the Right Hon. W. E. Forster, Vice-President of the Committee of Council on Education; the Right Hon. Earl of Harrowby, of Sir Thos. Bazley, Bart., Mr. Hugh Birley, and Mr. Jacob Bright, the members for Manchester; the Right Hon. Col. Wilson Patten, Mr. Wm. Rathbone, and other members of Parliament.

The Owens College Extension Act appoints 21 Life Governors, who have power to elect three colleagues, and the 24 may then elect a President; and the subscribers are now recommended to authorize the Executive Committee to hand over to this new body (so soon as they shall be in a position to receive them) the new College site and the extension funds, so that the new Governors may then arrange with the Trustees of Owens College a scheme for amalgamation to submit to the Commissioners for Charitable Trusts, in order to carry out the provisions of the Owens Extension College (Manchester) Act.

#### LIST OF SUBSCRIPTIONS.

##### I.—General Fund.

	£	s.	d.		£	s.	d.				
Thomas Ashton, Esq.	-	-	1,000	0	0	Wm. Horsfall, Esq.	-	-	200	0	0
Chas. F. Beyer, Esq.	-	-	1,000	0	0	Samuel Schuster, Esq.	-	-	200	0	0
Messrs. W. R. Callender and Sons	-	-	1,000	0	0	Joseph Thompson, Esq.	-	-	200	0	0
Messrs. G. and R. Dewhurst	-	-	1,000	0	0	Miss Ashton	-	-	150	0	0
James Heald, Esq.	-	-	1,000	0	0	Evening Students' Committee	-	-	242	9	0
Messrs. A. and S. Henry and Co.	-	-	1,000	0	0	Henry Sampson, Esq.	-	-	100	0	0
John Snowden Henry, Esq., M.P.	-	-	1,000	0	0	John Alcock, Esq.	-	-	100	0	0
John Heugh, Esq.	-	-	1,000	0	0	Samuel Barlow, Esq.	-	-	100	0	0
Messrs. Heywood Brothers and Co.	-	-	1,000	0	0	Spencer H. Bickham, Esq.	-	-	100	0	0
Henry Houldsworth, Esq.	-	-	1,000	0	0	W. T. Blacklock, Esq.	-	-	100	0	0
Richard Johnson, Esq.	-	-	1,000	0	0	Charles Blackburn, Esq.	-	-	100	0	0
John L. Kennedy, Esq.	-	-	1,000	0	0	William Blythe, Esq.	-	-	100	0	0
Ivie Mackie, Esq.	-	-	1,000	0	0	Jacob Bright, Esq., M.P.	-	-	100	0	0
Sam. Mendel, Esq.	-	-	1,000	0	0	Right Hon. John Bright, M.P.	-	-	100	0	0
John Pender, Esq.	-	-	1,000	0	0	Edward Buckley, Esq.	-	-	100	0	0
Messrs. J. and N. Philips	-	-	1,000	0	0	William Carver, Esq.	-	-	100	0	0
Edmund Potter, Esq., F.R.S., M.P.	-	-	1,000	0	0	Messrs. Chadwicks, Adamson, and Co.	-	-	100	0	0
Robert Stuart, Esq.	-	-	1,000	0	0	Henry Charlewood, Esq.	-	-	100	0	0
Messrs. Tootal, Broadhurst, Lee and Co.	-	-	1,000	0	0	Professor R. C. Christie	-	-	100	0	0
Sir Joseph Whitworth, Bart.	-	-	1,000	0	0	J. Ashton Critchley, Esq.	-	-	100	0	0
James Worthington, Esq.	-	-	1,000	0	0	W. G. Crum, Esq.	-	-	100	0	0
Thomas Wrigley, Esq.	-	-	1,000	0	0	Messrs. James Dilworth and Sons	-	-	100	0	0
Overseers of Manchester	-	-	1,000	0	0	Messrs. Dobson and Barlow	-	-	100	0	0
Wm. and Thomas Agnew, jun., Esqs.	-	-	500	0	0	Edwin S. Fletcher, Esq.	-	-	100	0	0
Sir E. Armitage and Sons	-	-	500	0	0	John S. Fletcher, Esq.	-	-	100	0	0
Wm. Atkinson, Esq.	-	-	500	0	0	Frederic Adolphus Fynney, Esq.	-	-	100	0	0
Sir Thos. Bazley, Bart., M.P.	-	-	500	0	0	Rev. Canon Gibson	-	-	100	0	0
Solomon L. Behrens, Esq.	-	-	500	0	0	John Grave, Esq., Mayor of Manchester	-	-	100	0	0
The late Right Hon. Lord Derby	-	-	500	0	0	Messrs. J. and J. L. Gray	-	-	100	0	0
Right Hon. Lord Egerton	-	-	500	0	0	Professor J. G. Greenwood	-	-	100	0	0
Sir Wm. Fairbairn, Bart., LL.D., F.R.S.	-	-	500	0	0	Edward Hardcastle, Esq.	-	-	100	0	0
John Fernley, Esq.	-	-	500	0	0	William Hinners, Esq.	-	-	100	0	0
Murray Gladstone, Esq.	-	-	500	0	0	Messrs. S. Hodgkinson and Co.	-	-	100	0	0
Messrs. John Dugdale and Brother	-	-	500	0	0	John Holliday, Esq.	-	-	100	0	0
Messrs. Shaw Jardine and Co.	-	-	500	0	0	J. H.	-	-	100	0	0
Fred. W. Grafton, Esq.	-	-	500	0	0	Henry B. Jackson, Esq.	-	-	100	0	0
Messrs. Greg Brothers and Co.	-	-	500	0	0	Thomas Johnson, Esq.	-	-	100	0	0
Messrs. J. C. Harter and Co.	-	-	500	0	0	Samuel Knowles, Esq.	-	-	100	0	0
E. R. Langworthy, Esq.	-	-	500	0	0	J. L.	-	-	100	0	0
Bernard Liebert, Esq.	-	-	500	0	0	Messrs. Lockett, Sons, and Leake	-	-	100	0	0
Lewis Loyd, Esq.	-	-	500	0	0	Messrs. W. and R. K. Lee	-	-	100	0	0
Messrs. Lyon, Lord, and Co.	-	-	500	0	0	Messrs. Charles Mackintosh and Co.	-	-	100	0	0
Right Hon. Lord Overstone	-	-	500	0	0	Colin Mather, Esq.	-	-	100	0	0
James McConnell, Esq.	-	-	500	0	0	Messrs. Duncan Matheson and Co.	-	-	100	0	0
Henry McConnell, Esq.	-	-	500	0	0	John S. Mayson, Esq.	-	-	100	0	0
Hugh Mason, Esq.	-	-	500	0	0	Wm. Mothersill, Esq.	-	-	100	0	0
James Murray, Esq.	-	-	500	0	0	J. C. Needham, Esq.	-	-	100	0	0
Messrs. Platt Brothers and Co.	-	-	500	0	0	Robt. Neill, Esq.	-	-	100	0	0
Messrs. Rylands and Sons	-	-	500	0	0	Henry D. Pochin, Esq.	-	-	100	0	0
Sigismund J. Stern, Esq.	-	-	500	0	0	H. P. Ree, Esq.	-	-	100	0	0
John Edward Taylor, Esq.	-	-	500	0	0	Julius Reiss, Esq.	-	-	100	0	0
Messrs. Todd and Coston	-	-	500	0	0	Emil Reiss, Esq.	-	-	100	0	0
Messrs. Jas. Walton and Sons	-	-	500	0	0	Samuel Robinson, Esq.	-	-	100	0	0
Messrs. S. and J. Watts and Co.	-	-	500	0	0	Professor H. E. Roscoe	-	-	100	0	0
Benjamin Whitworth, Esq.	-	-	500	0	0	R. Rumney, Esq.	-	-	100	0	0
James Reiss, Esq.	-	-	500	0	0	Francis J. Schuster, Esq.	-	-	100	0	0
Day Students	-	-	446	1	0	Messrs. Butterworth and Brooks	-	-	100	0	0
Messrs. John H. Agnew and Brother	-	-	300	0	0	Peter Spence, Esq.	-	-	100	0	0
Messrs. Robert Barbour and Brother	-	-	300	0	0	John Thom, Esq.	-	-	100	0	0
Alfred Neild, Esq.	-	-	300	0	0	Wm. Rumney, Esq.	-	-	100	0	0
Anonymous, per T. Ashton, Esq.	-	-	250	0	0	G. W. R. Wood, Esq.	-	-	100	0	0
Charles Andrew, Esq.	-	-	250	0	0	Mrs. Shuttleworth	-	-	100	0	0
Frank W. Ashton, Esq.	-	-	250	0	0	Art Treasures Exhibition Balance	-	-	83	11	4
George E. Balfour, Esq.	-	-	250	0	0	Hy. Ogden, Esq.	-	-	60	0	0
John A. Bremner, Esq.	-	-	250	0	0	Messrs. Hewitt and Paull	-	-	52	10	0
John Carlisle, Esq.	-	-	250	0	0	Messrs. John Andrew and Co.	-	-	50	0	0
Fred. Craven, Esq.	-	-	250	0	0	J. P. Aston, Esq.	-	-	50	0	0
Robt. D. Darbshire, Esq.	-	-	250	0	0	Professor Barker	-	-	50	0	0
						Messrs. Binyons, Robinson, and Co.	-	-	50	0	0



	£	s.	d.		£	s.	d.	J. G. Green-wood, Esq., B.A.
Messrs. Codling, Swain, and Hodgkinson	50	0	0	M. Bateson Wood, Esq.	20	0	0	
Alfred Crewdson, Esq.	50	0	0	Thos. Worthington, Esq.	20	0	0	
Nathaniel Dodd, Esq.	50	0	0	In smaller sums	129	19	0	31 March 1871.
J. B. Edmundson, Esq.	50	0	0	<i>Subscriptions per the Bolton Committee.</i>				
Mrs. Samuel Fletcher	50	0	0	Messrs. Barlow and Jones	250	0	0	
F. H.	50	0	0	Messrs. Crosses and Winkworth	250	0	0	
Messrs. Hocken, Bird, and Cole	50	0	0	Robert Heywood, Esq.	250	0	0	
W. W. Hulse, Esq.	50	0	0	Messrs. Martin and Johnson	250	0	0	
Professor Jack	50	0	0	Henry Ashworth, Esq.	100	0	0	
Messrs. E. and J. Jackson	50	0	0	<i>Subscriptions per the Oldham Committee.</i>				
Professor Jevons	50	0	0	John Robinson, Esq., ex-Mayor	105	0	0	
George Lyon, Esq.	50	0	0	<i>II.—Engineering Fund.</i>				
Adam Murray, Esq.	50	0	0	Messrs. Beyer, Peacock, and Co.	3,000	0	0	
Messrs. S. A. Meyer and Co.	50	0	0	John Robinson, Esq.	1,000	0	0	
Edwd. Nathan, Esq.	50	0	0	Charles P. Stewart, Esq.	1,000	0	0	
J. Holme Nicholson, Esq.	50	0	0	Sir Joseph Whitworth, Bart., D.C.L., F.R.S.	1,000	0	0	
Penalty for breach of contract, paid to and presented by F. W. A.	50	0	0	Sir William Fairbairn, Bart., LL.D., F.R.S.	500	0	0	
Dr. Chas. D. F. Phillips	50	0	0	Messrs. P. R. Jackson and Co.	500	0	0	
Edwd. Reiss, Esq.	50	0	0	Messrs. Platt Brothers and Co.	500	0	0	
Joseph S.	50	0	0	John Ramsbottom, Esq.	300	0	0	
Wm. Slater, Esq.	50	0	0	Messrs. J. and W. Galloway	250	0	0	
Bryce Smith, Esq.	50	0	0	Stephen Robinson, Esq.	250	0	0	
Emil M. Stöher, Esq.	50	0	0	Messrs. Mather and Platt	200	0	0	
Messrs. H. and H. S. Strauss	50	0	0	Edward T. Bellhouse, Esq.	100	0	0	
T. W. Tatton, Esq.	50	0	0	John Carlisle, Esq.	100	0	0	
Professor Theodoros	50	0	0	Matthew Curtis, Esq.	100	0	0	
Professor Ward	50	0	0	Messrs. Dobson and Barlow	100	0	0	
Thomas Warner, Esq.	50	0	0	John Hawkshaw, Esq., F.R.S.	100	0	0	
Thos. George Webb, Esq.	50	0	0	Messrs. John Hetherington and Sons	100	0	0	
Professor Williamson	50	0	0	George Parr, Esq.	100	0	0	
William Woodcock, Esq.	50	0	0	George Peel, Esq.	100	0	0	
Robert Faulkner, Esq.	50	0	0	Messrs. Wren and Hopkinson	100	0	0	
John Tysoe, Esq.	50	0	0	J. C. Kay, Esq.	50	0	0	
Thomas Chadwick, Esq.	30	0	0	Omega	30	0	0	
Williamson Dunn, Esq.	30	0	0	R. Cunliffe, Esq.	25	0	0	
Jeremiah Garnett, Esq.	30	0	0	James Ashbury, Esq., Mexican Bonds, nominal value (8 per cent. guaranteed for three years)	4,000	0	0	
P. Goldschmidt, Esq.	30	0	0		£13,505	0	0	
Edwd. Johnson, Esq.	30	0	0	<i>III.—Proposed Natural History Fund.</i>				
J. W. Maclure, Esq.	30	0	0	Manchester Natural History Society—	£	s.	d.	
Messrs. J. and H. Patteson	30	0	0	Contribution to Building Fund	5,000	0	0	
Henry Samuels, Esq.	30	0	0	Contribution to Endowment—say	8,000	0	0	
Alfred Watkin, Esq.	30	0	0	Collections, valued at				
Peter Allen, Esq.	25	0	0		£13,000	0	0	
Jacob Behrens, Esq.	25	0	0	<i>IV.—Endowment Fund.</i>				
John Chadwick, Esq.	25	0	0	Chas. F. Beyer, Esq.	3,000	0	0	
Messrs. Wm. Hoyle and Brother	25	0	0	John Fielden, Esq.	1,000	0	0	
James Hurst, Esq.	25	0	0	Joshua Fielden, Esq., M.P.	1,000	0	0	
Alderman J. King	25	0	0	Samuel Fielden, Esq.	1,000	0	0	
Messrs. Lloyd and King	25	0	0	Thos. Ashton, Esq.	1,000	0	0	
Thos. McConnell, Esq.	25	0	0	W. H. Houldsworth, Esq.	1,000	0	0	
Wm. Norris, Esq.	25	0	0	Robert Stewart, Esq. (conditional)	1,000	0	0	
C. S. Roundell, Esq.	25	0	0	Richard Johnson, Esq.	500	0	0	
H. S. Strauss, Esq.	25	0	0		£9,500	0	0	
Robert Lawrie, Esq.	21	0	0	<i>Total Subscriptions.</i>				
Executors of the late James Woolley	20	0	0	I.—General Fund	59,025	12	2	
William Brockbank, Esq.	20	0	0	II.—Engineering Fund	13,505	0	0	
Wm. Scott Brown, Esq.	20	0	0	III.—Natural History Fund—say	13,000	0	0	
Thomas Carrick, Esq.	20	0	0	IV.—Endowment Fund	9,500	0	0	
Messrs. J. Cooper and Son	20	0	0	Value of Present Site—say	7,000	0	0	
Henry Thomas Darnton, Esq.	20	0	0		£102,030	12	2	
David Duncan, Esq.	20	0	0	Royal Institution, Manchester, July 1870.				
Messrs. Hess and Bucking	20	0	0					
Moritz Kauffman, Esq.	20	0	0					
W. D. Mather, Esq.	20	0	0					
Samuel Ogden, Esq.	20	0	0					
John Peiser, Esq.	20	0	0					
Messrs. Sparrow and Hardwick	20	0	0					
Fox Turner, Esq.	20	0	0					
Wm. J. Williams, Esq.	20	0	0					

## OWENS COLLEGE EXTENSION.

DR.	Receipts and Expenditure of the Executive Committee,										
			£	s.	d.				£	s.	d.
To Subscriptions received	-	-	53,945	15	4	By Property and Law Expenses	-	-	30,189	9	0
„ Rents	-	-	985	5	11	„ Parliamentary Expenses	-	-	350	0	0
„ Bank Interest	-	-	116	1	5	„ Travelling and Deputation Expenses	-	-	223	1	10
„ Old Materials	-	-	587	5	11	„ Printing and Stationery	-	-	144	3	4
						„ General Law Expenses	-	-	146	16	6
						„ Salaries	-	-	651	0	0
						„ Sundries	-	-	22	16	9
						„ Interest to Bankers	-	-	492	12	4
						„ Trustees of Owens College	-	-	200	9	10
						„ Endowment Fund—Invested with Corporation of Manchester	-	-	8,000	0	0
						„ Balance	-	-	15,213	18	11
20th July 1870.			£55,634	8	7				£55,634	8	7



J. G. Greenwood, Esq., B.A.  
31 March 1871.

At the meeting of subscribers, held in the Mayor's parlour of the Town Hall, Manchester, 22d July 1870, Thos. Ashton, Esq., in the chair,  
The circular calling the meeting having been read, the Secretary (Dr. J. Watts) read the report and the statement of accounts.

The Chairman then moved, "That the report now presented be accepted and approved, and that the Executive Committee be authorised, when the accounts have been audited, to hand over to the new governors (so soon as they shall be in a position to receive them) the extension funds and the site for the new College, so as to enable the new body to fulfil the requirements of the Owens Extension College (Manchester) Act."

He said that under the Act as it now stood the 21 Life Governors had met and filled up their number to 24 by the election of the Lord Bishop of Manchester, Mr. Henry Rogers, Principal of the Independent College, and Mr. Edward Behrens. The first meeting of the Life Governors would take place some time next week, when a President would be appointed and the board constituted, and they would then be able to take over the whole property that had been subscribed. The fund had increased since the last meeting by about 12,000*l.* Part of it had been appropriated to the endowment fund, and it might be well to state that the cost of the natural history museum, which would have to be paid within the next three or four years, in accordance with the agreement with the Natural History Society, and the amount required for endowment for immediate purposes, would still oblige them to appeal to the public for about 50,000*l.* more than they had got. If they could get that sum within the next three or four years, they would never be in pecuniary trouble. The new buildings had proceeded, perhaps, more slowly than any of them wished, but he could scarcely say that blame attached to anybody. The delays had arisen in every instance from the desire of the Architect and of the Committee to have the buildings as perfect as possible. Many delays had arisen from alterations which were found necessary upon the plans as originally drawn, and there had been considerable delay through the great difficulty there was in getting the "quantities" turned out by the architect's employés. They had advertised for contracts, and he hoped that the work would now go on rapidly. He still hoped that some portion of the buildings would be ready in a couple of years.

Mr. W. H. Houldsworth seconded the motion, which was agreed to unanimously.

#### OWENS EXTENSION COLLEGE.

President :

His Grace the DUKE OF DEVONSHIRE, K.G., F.R.S.

Treasurer and Chairman of the Council : ALFRED NEILD.  
Chairman of the Extension Committee : THOS. ASHTON.  
Chairman of the Senate : THE PRINCIPAL.

Royal Institution, Manchester,

DEAR SIR, Nov. 8th, 1870.

THE Extension Committee have great pleasure in stating that the preliminary arrangements for the erection of the new college buildings are now completed, and that the contractors expect to make rapid progress in the work. Under these circumstances the funds in hand will soon be exhausted, and the Committee will be glad if you will kindly pay into the bank of Messrs. Heywood Brothers & Co. the balance of your subscription, or such proportion thereof as may be convenient.

As an additional sum of about 30,000*l.* will be needed to finish and furnish the buildings, the Committee would esteem it a great favour if you could lend them your aid by canvassing your friends in favour of the scheme, or by giving them intimation of any probable subscribers within the circle of your acquaintance.

I enclose a list of subscriptions up to the present date, and am,

Dear sir, yours faithfully,

JOHN WATTS, Ph.D.,  
Secretary to the Extension Committee.

#### SUPPLEMENTARY LIST OF SUBSCRIPTIONS.

I.—Building Fund.		£	s.	d.
The Duke of Devonshire	-	1,000	0	0
J. B. Smith, M.P.	-	1,000	0	0
Miss Brackenbury	-	500	0	0
Messrs. R. Haworth & Co.	-	500	0	0
W. McConnell	-	500	0	0
Alfred Waterhouse	-	200	0	0
Thomas Clay	-	200	0	0
Mrs. Samuel Fletcher (2nd subsc.)	-	50	0	0
George Hadfield, M.P.	-	50	0	0

	£	s.	d.
Rev. F. P. Napier, B.A., Associate, Hangkow	50	0	0
Messrs. Railton, Sons, and Leedham	50	0	0
Fereday Smith	50	0	0
In smaller sums	20	0	0

#### II.—Laboratory Fund.

Messrs. Gaskell, Deacon, & Co., Widnes	-	300	0	0
Messrs. W. Gossage & Son, Widnes	-	300	0	0
Messrs. Muspratt, Liverpool	-	300	0	0
H. D. Pochin (2nd subsc.)	-	300	0	0
Peter Spence (2nd subsc.)	-	300	0	0
William Blythe, Accrington (2nd subsc.)	-	100	0	0
Edward Hunt	-	50	0	0

#### III.—Endowment Fund.

Miss Brackenbury	-	1,000	0	0
Thos. Ainsworth, Cleator	-	500	0	0
		£7,320	0	0
Duke of Devonshire	-	1,000	0	0

#### TOTAL SUBSCRIPTIONS.

Building Fund	-	-	-	-	63,800	0	0
Laboratory Fund	-	-	-	-	1,650	0	0
Endowment Fund	-	-	-	-	12,000	0	0
Natural History Fund (say)	-	-	-	-	13,000	0	0
Engineering Fund	-	-	-	-	13,505	0	0
Value of present Site (say)	-	-	-	-	7,000	0	0
					£111,000	0	0

7266*a*. Did I rightly understand you to say that 45,000*l.* is the addition required for the building purposes alone?—Yes, and 5,000*l.* of that we can take from the Natural History property; therefore, there remain 40,000*l.* required for building purposes alone, including the museums, which we must raise before we can appropriate the collections.

7267. Are the other two funds tolerably adequate for what you require?—By no means. The Laboratory Fund is still in its infancy; Dr. Roscoe hopes to raise it to double the amount; but the cost of the laboratory would be not less than 10,000*l.* Therefore, until this amount of 10,000*l.* is raised, the laboratory will be a charge upon the General Building Fund, but if we can raise this by a special fund, the general fund will be released to that extent. The Endowment Fund, again, at present amounts to 12,000*l.*; of that sum, as I said before, some portions are general, and some are specially appropriated; but the total sums for endowment alone amount to 12,000*l.* That does not include the Engineering Fund, which has been all along a separate fund.

7268. Can you state to the Commission what was the answer to the application which you made to the Government?—Our first application to Mr. Disraeli's Government (and we made two applications, one to the Treasury and one to the Privy Council), was practically a favourable answer, so far I mean as the justness of our application was concerned, and so far as the intentions of the Government were revealed. No actual promise was made to us; but Lord Robert Montagu, in his evidence before Mr. Samuelson's Committee, if I remember rightly, distinctly stated that the proposal to give us a grant had been made before he left office. The paper which I hold in my hand is a Memorial, which was put before Lord de Grey in the spring of last year, and in the postscript to that we say as follows:—"In justification of the hopes referred to in the first paragraph of the foregoing memorandum we may appeal to a statement of Lord Robert Montagu in the House of Commons in July last, in a debate on the estimates as to the grant to the University of Glasgow; to the statements made by Lord Robert and others before Mr. Samuelson's Committee (see Blue Book, questions 7874, 7882, 7929, 7930); and in particular to an important passage in a Minute of the Privy Council, dated 27th March 1868, on the then recently made gift by Mr., now Sir Joseph Whitworth, of 100,000*l.* for the promotion of mechanical science, and which minute was communicated to Mr. Whitworth and afterwards published. The passage is as follows:—



"It is the wish of My Lords to see provision made in several large centres of manufacturing industry in the United Kingdom for affording to all classes of Her Majesty's subjects ample opportunities for acquiring instruction in the sciences which are applicable to productive industry. My Lords are of opinion that by the union of local and private efforts, supplemented as far as is proper by State assistance, this provision will best be made." Then in the Blue Book, the Commission will find that the question put by Mr. Potter to Lord Robert Montagu was as follows:—

"You had no idea of making any such addition to, for example, the funds of Owens College?—(A.) That would depend very much on the locality itself; it was to be a matter of negotiation with the locality. (Q.) Suppose at Manchester Owens College found 100,000*l.*, it did not enter into your contemplation to add another 100,000*l.*? (A.) I have already stated that it was to be a matter of negotiation with the localities. We had not determined to give equal sums; at one time we thought we should do so, but finally that was not determined." The next question is: (Q.) "Is it your lordship's opinion that 25,000*l.* a year for ten years would be an effective amount" [i.e., for the suggested series of science colleges]. And the answer is: "The estimate was made by Mr. Cole, and put in print. I have not looked at it for some months now; not, I think, since the opening of Parliament; and I cannot remember the figures, but to the best of my memory it amounted to 25,000*l.* a year for ten years." Then at question 7874, Lord Robert Montagu puts this question to Captain Donnelly:—"We thought that besides the one in London, there should be science colleges in Yorkshire, the Midland Counties, the West of England, and also Owens College in Manchester? (A.) Yes, there was to be a grant for Owens College." That, of course, is a definite statement that the minute, which was drawn up but not recorded, contemplated a grant to us, and, therefore, we had not a promise, as I said before, from the Government, but something very like an understanding that a grant would be made to us. Then, in 1869, an application was made to the Treasury, under Mr. Gladstone's Ministry, and I can put in here the text of that application; it was a Memorial to the Treasury, making an application for a grant under the then circumstances of the case. I have here a minute of our Committee drawn up in consequence of the answer made to us on that occasion by Mr. Gladstone, who received the deputation. I may say that the answer was not a refusal, nor was it an assent; but I may read the following short paper:—"The Chairman of the Committee having, in his report of the interview between the Right Honourable the First Lord of the Treasury and the deputation appointed to lay before the Government the application of this Committee for a grant in aid from the National Exchequer, stated that one principal difficulty in the way of making a grant appeared to be the apprehension on the part of the Treasury, that to give it would be to lay down a precedent, under which every principal town in the country might urge a like claim, the following minute has been drawn up of the grounds on which alone, as it appears to this Committee, such claims could be justified. The Committee hold that in the case of colleges founded in the chief centres of population and of national development, the right to receive pecuniary aid from the public exchequer is undeniable. In their opinion such aid ought to be granted in every case where, after sufficient inquiry, certain conditions may be shown to co-exist. These conditions may be stated as follows:—

1. Such a college must be an already-established institution, enjoying a substantial and recognised success, and materially endowed by local munificence.
2. Its government must be in the nature of a public trust, with due guarantees for the maintenance of the principle of the foundation and of the character of the administration.
3. Its constitution

"must be undenominational. 4. Its location must be central with regard to a population which can furnish students, and with regard to peculiar aptitude for the development of some specific line of education. The Committee are convinced that, with regard to each of these conditions, the claims of the Owens College and its extension scheme, as enumerated in their memorial, are of sufficient weight to justify their application to Her Majesty's Government for a pecuniary grant in augmentation of the local funds with which the College has been founded and maintained and is about to be extended. At the same time they submit that the institutions in which such conditions can effectually co-exist can never within the limits of the United Kingdom be more than very few in number."

7269. Has anything subsequently passed upon this subject between Owens College and the Government?—Yes. In the spring of last year a deputation waited upon Lord de Grey, and at Lord de Grey's and Mr. Forster's request we proceeded to draw up a memorandum of our application to the Government for aid to our extension fund. It was not printed, it was sent in and favourably received. I believe it has been laid before the Treasury, and I think the answer is still pending, or at least is expected by us. The memorandum is as follows:—

"Memorandum on the application to the Government for aid to the Owens College Extension Fund.

"To the Right Honourable the Earl de Grey and Ripon, K.G., Lord President of the Privy Council.

"In addressing you as to the application which it is proposed again to make to the Government for aid from the national exchequer to the Owens College extension fund, we beg leave to call attention to two circumstances which seem to us at the present time to give increased urgency to this application; (1.) That in the two years during which our scheme has been maturing, its proportions have gradually grown under our hands, not only from the rapid development of the College and from the juster estimate which is now generally entertained of what is necessary for a school of science of the first rank, but also—and that in no small measure—from the very favourable way in which two deputations in February and March 1868 were received by leading members of the late ministry, and from the hopes which we cannot but think we were justified in forming that we should receive substantial aid from the Government; and (2) that while the scale on which almost in spite of ourselves we have been led to plan our buildings has thus increased, the serious and still continuing depression of this district has made and still makes it impossible to organize any wide-spread canvass or to expect any large immediate additions to the funds we have raised.

"I. The state of our finances is at this time as follows:

"A site of considerable extent (about four acres) and admirably situated, has been purchased for 30,000*l.*

"Building plans have been prepared, after long and careful deliberation with the architect to the new College, Mr. A. Waterhouse, such that those portions which are immediately necessary can be built at once, while the erection of museum, library, and public hall can be deferred until the funds required for them shall be found. For the erection of these indispensable portions, including the cost of draining, levelling, &c., a careful estimate shows that not less than 50,000*l.* will be needed, and it would not be safe to put down less than 10,000*l.* more for the necessary internal fittings.

"Lastly, the large and excellent collections of the Natural History and Geological Societies of Manchester have been made over to us, together with considerable property for endowment, on condition

J. G. Greenwood, Esq., B.A.  
31 March 1871.



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31 March 1871.

" that a fitting building is provided for their reception, and that they shall be maintained in due efficiency for the use of the public as well as of the students of the College. The erection of this museum will cost not less than 15,000*l.*, or 10,000*l.* more than the sum contributed for that purpose by the Natural History Society.

" A total outlay of not less than 100,000*l.* (the cost of the land included) will thus be called for within the next few years. To meet this the general subscription fund amounts to about 58,000*l.*, and the estimated value of the present College and site gives 7,000*l.* more.

" The final result is, we have a deficit of 35,000*l.*, no account being taken of the library and public hall, nor (what is of greater importance) of those extensions of the teaching power and appliances which, even now loudly called for, will in the extended College be absolutely indispensable.

" II. It may, we assume, be taken as admitted that the higher education has under no circumstances been anywhere self-supporting, and if this is true of the liberal training ordinarily supplied in universities and colleges, it is obvious that the far greater cost of the higher culture in science will fail in a still greater degree to be met by the fees which are likely to be paid by students.

" We have made a very careful calculation of the ascertained average cost of each of the considerable number (108) of science students in Owens College in the session 1868-9. Premising that no account is taken in this estimate of the value of building laboratories and collections, and also that from a desire not to overstate the case one half only of the cost of the department of pure mathematics has been set down to the science classes, we get the following results:—The average payment made by each student in the science classes was 14*l.* 14*s.* 8*d.*, and the total net cost of each to the College funds after deducting that portion of the fees which is paid in to the College chest, was 25*l.* 10*s.* 11*d.* The net cost of each of the (102) art students calculated in the same way was 16*l.* 1*s.*, or more than one third less than the average cost in science.

" Now, it is certain that if a comparison be made with the most successful Polytechnic Institutions and Science Schools in Germany, France, and Switzerland, and with the only institutions of the kind in the United Kingdom, which are at all complete, the Science Department in Owens College is, so to say, starved; that more professors and skilled assistants are needed, and that larger sums are required for illustration of lectures and other appliances of good teaching. With this proviso, and if we assume as the basis of our calculation the careful estimate made by Professor Roscoe for the Committee on Scientific Instruction (Blue Book, page 351, question 6940) that in a college containing 200 science students, a number which we shall probably soon reach in the extended College, the cost per head to the endowment, and exclusive of fees paid by the students, would be about 23*l.*, we should find that the net cost of the department would amount to 4,600*l.*, a sum larger than the net income of the College from all sources, and more than double that portion of the income which can with justice be allotted to the Science Department alone. If the number of students should in the course of years exceed 200, the increased income from fees would probably not do more than meet the increased cost of maintenance."

" III. We will now venture to suggest the form in which we believe we could be most effectively aided by Government. In our applications both to the late and to the present administration, we asked for the grant of a considerable sum on the precedent supplied by the grant of 120,000*l.* in aid of the building fund of the Glasgow University. It would perhaps be not less welcome to us if, instead of a single grant of large amount, a grant were made to us in aid of the building fund of such a sum as would

" enable us at once to erect the indispensable portions of the new buildings, and at the same time of an annual subsidy such as would place the Scientific Departments in a state of thorough efficiency. We may cite in support of this second proposal the large sums annually granted by Parliament for the maintenance of the School of Mines in Jermyn Street, and of the Royal School of Science in Dublin, and also the grant of 200*l.* a year for the newly-established professorship of engineering in Edinburgh, to meet an equal sum furnished by the income from the endowment of that chair by Sir David Baxter. We beg leave to offer the following estimate:—The wants of the College will require not fewer than seven chairs in the department, viz., (1) Mathematics, (2) Natural Philosophy, (3) Chemistry, (4) Metallurgy and Mining, (5) Geology, (6) Physiology and Botany, (7) Engineering. Each of these chairs will require one, and some of them more than one, skilled assistant, and the sums necessary for the maintenance of each chair will be considerable. If, then, the Government would grant 30,000*l.* towards the erection and fittings of the new buildings (including, of course, the museum) and an annual sum averaging 300*l.* towards the expenses of each of the chairs enumerated, or say 2,000*l.* per annum, we believe that they would thus secure the establishment in Owens College of a complete and thoroughly efficient school of science placed in the centre of a population more ready perhaps to avail themselves of the advantages offered than the inhabitants of any other equally populous district in the kingdom." The next paragraph proceeds to state how we think we could give a *quid pro quo*, as the homely phrase is, for such assistance as that:—"It only remains to state more fully the public services which, we believe, that the College, thus strengthened, would render, and which ought to be of such a kind as to justify the liberal aid which we are asking from the national exchequer: (1.) In the first place, we submit that the admirably planned School of Mines in Jermyn Street does not and cannot meet the whole needs of the nation in this matter of the higher science culture. The conditions of English life must for a long time, and perhaps always, make it impossible that many of the middle class or that more than a very few of the artisan class should resort for this culture to London or to any considerable distance from their homes; and when the eminence of the professors assembled in Jermyn Street and in other London Colleges, and the completeness of the preparations made for the illustration of their lectures are considered, it will follow from the comparatively small number of students who are attracted from a distance to attend their classes, that more than one such centre of the highest scientific teaching should be provided. Owens College would give that teaching in the district where it would be at once most useful and most warmly welcomed. (2.) In the next place, the College would of course open its science classes free of fee to all Queen's scholars. (3.) Certificated schoolmasters would be admitted at a low or merely nominal fee to such courses as were adapted to their wants. (4.) Courses of evening lectures would be given, as in Jermyn Street, at a fee so low that artisans would be able to attend them. The evening classes are already attended by more than 400 members (now between 500 and 600), "the majority of whom are young men of very moderate means, and not a few are artisans. In the public museum to be attached to the College, mechanics and artisans would be able to find, together with the assistance of an able curator, complete illustrations of those branches of science to which they are most often attracted. (5.) We may add further that the authorities of the College would, if requested to do so, readily superintend the examinations in Manchester of the Science and Art Department, and make themselves responsible for their integrity. How important those examinations are in this portion of the kingdom is



" seen from the fact that whereas the population of the district covered by the Lancashire and Cheshire Union of Institutes is only one fifteenth of the population of the United Kingdom, more than one fifth of the teaching in connexion with the Department of Science and Art is carried on within the limits of the Union, and not less than two fifths of the highest honours awarded in the last year were gained by its pupils. In conclusion, we invite attention to the steps we are already taking to obtain the incorporation by Act of Parliament of the Governors of the extended College, and the grant of an improved constitution, and in particular to the clause in which it is proposed that, among other representatives of important public interests, three governors should be nominated by the Lord President of the Privy Council. A sufficient guarantee would thus be provided for the due performance of those public services for the sake of which we are now applying for the assistance of the Government."

7270. (*Mr. Samuelson.*) What became of your application for an Act of Incorporation?—The Act of Incorporation has been granted by Act of Parliament last year. I will put in a copy of the Act of Parliament itself, which contains in the schedule the full constitution of the College.

7271. Did the Committee consider whether, beyond the appointment of three governors being vested in the Privy Council, any other control might be given to the Government either in reference to the appointment of the professors or to the course of studies in consideration of the grant which was asked from the Government?—That did not arise. It was considered by the Committee, and I think I could perhaps not safely say more at the present moment, than that such a proposal is a fair matter of negotiation between the Government and the governors of the College.

7272. But the Commission might take it that the Committee would not consider that every reasonable requirement on the part of the Government had been met by their merely consenting to the appointment of three governors?—In my opinion they would not.

7273. (*Chairman.*) Is there any portion of the Act to which you think it desirable that the attention of the Commission should be specially directed?—Yes; the second schedule to the Act contains the constitution of the College, and it is as follows:—

#### THE SECOND SCHEDULE.

##### *Constitution of the College.*

It is a fundamental condition of the constitution of the College, that no student, professor, teacher, or other officer or person, connected with the institution, shall be required to make any declaration as to, or to submit to any test whatsoever of, his religious opinions, and that nothing shall be introduced in the matter or mode of education or instruction, in reference to any religious or theological subject, which can be reasonably offensive to the conscience of any student, or of the relations, guardians, or friends, under whose immediate care he may be.

The government of the College shall be vested in an official head, to be called President, and the three following bodies, namely:

- I. The Court of Governors.
- II. The Council.
- III. The Senate.

The Court to be the supreme governing body.

The Council to be a committee managing the financial and other ordinary business of the College, and preparing questions for the decision of the Court.

The Senate to organise and direct the education of the College, and superintend its discipline.

Both Senate and Council to be responsible to the Court for the proper discharge of their functions.

#### THE COURT OF GOVERNORS.

The Court shall consist of the president and 42 members:

- (a) Twenty-four governors shall be appointed for life, being at the time of their appointment persons residing, or having their usual place of business,

within fifty miles of Manchester, and not being members of the Senate. Such governors shall cease to hold office on the failure of this qualification, but may be re-elected, provided that there shall not at any time be less than 16 life governors who are qualified as aforesaid.

*J. G. Greenwood, Esq., B.A.*  
31 March 1871.

The first Life Governors named in the third schedule to this Act shall, so soon as conveniently may be, proceed to fill up the number of governors to 24. Vacancies amongst the life governors by resignation, non-residence, or otherwise, shall for the future be filled up as they occur, and within twelve months, by the continuing members of the court.

- (b) Fifteen governors shall hold office on nomination as after mentioned, and (except as to members of Parliament) for terms of five years only from the date of nomination.

- (1.) Three shall be nominated by the President.

- (2.) Two shall be nominated by the Council of the city of Manchester, and one by the Council of the borough of Salford, but these governors need not necessarily be members of those bodies.

- (3.) Three shall be nominated by the Court from among the members of Parliament for the counties and boroughs of Lancashire, Cheshire, Yorkshire, and Derbyshire, provided that no person so elected shall retain his seat on the court after he shall for six months have ceased to be a member of Parliament.

- (4.) Three shall be nominated by the Lord President of the Privy Council (or by any other member of Her Majesty's Government who may be discharging the functions of Minister of Education).

- (5.) Three shall be nominated by the associates of the College (as herein-after provided).

- (c) Three shall be the Principal and the two Professors who may for the time being be members of the Council (as herein-after constituted).

Not more than five members of the Senate shall at any one time be members of the Court.

Any governor absent from meetings of the court for 18 consecutive months shall vacate his seat, but shall be eligible for re-election.

For the first organisation of the Court the proceedings shall be as follows:—

The 24 life governors shall before their third meeting elect the first President and the first three Parliamentary Governors, and shall arrange with the President and with the corporations of Manchester and Salford, and with the Lord President of the Privy Council, for the completion of their respective nominations.

If, on this or any future occasion, two months shall elapse after notice to the respective nominors, that a vacancy awaits to be filled up by him or them, the Council shall cause to be given one month's further notice of the vacancy; after the expiration of such month, the vacancy or vacancies not filled up shall be filled up by the remaining governors at their next regular meeting.

All proceedings of the Court shall be valid prior to the appointment of any of the nominated governors, and notwithstanding any vacancy or vacancies.

The Court shall meet twice a year, at least, at fixed times, and at other times when convened by the President or Council, and shall

Be the supreme governing body of the College;  
Elect the President and Treasurer, and eight members of the Council;  
Have power to appoint committees;  
And to make and alter byelaws.

The quorum necessary to constitute a meeting of the Court shall be 15, and no resolution for election of president or treasurer, or members of the council, or for the removal of the principal or any professor, or for making or altering byelaws, shall be carried, unless at least two thirds of that number vote in its favour; other questions may be decided by majority. The chairman of the meeting may vote, and may have a second or casting vote. If the president be absent, the members of the court present, being a quorum, shall appoint a chairman for the meeting.



*J. G. Greenwood, Esq., B.A.*

31 March 1871.

Seven days' notice of all business, except as after mentioned, to be brought forward shall be sent to every member of the court, and no meeting shall be competent to transact any other business than such as shall directly arise out of the business so brought forward, or such business as shall have arisen since the issue of the summons for the meeting, and which shall yet for the satisfactory working of the institution require immediate determination.

#### THE PRESIDENT.

The President shall be elected by the Court for five years, and may be re-elected.

The functions of the President shall be:—

- (1.) To preside as chairman at meetings of the court, and at the opening and closing of the College sessions.
- (2.) To fill up his nominations in the court.
- (3.) To consider and, if he shall think fit, suspend and refer back to the court any byelaw passed by the court against which the council or the senate may appeal to him.

#### THE TREASURER.

The Treasurer shall be annually elected by the Court from amongst the governors, and may be re-elected.

The functions of the treasurer shall be:—

- (1.) To preside at meetings of the council when the president is absent.
- And generally under the direction of the council,
- (2.) To take charge of the College property and funds, investments, income and expenditure, and to keep proper books of account, and present to the council periodical accounts and reports as they may arrange.
- (3.) To keep and affix the College seal:
- (4.) And to provide and maintain proper registers and custody for the College muniments and securities.

#### THE COUNCIL.

The Council shall consist of the president and 12 members; of these eight shall be elected by the court from among the governors not being members of the senate, of whom one of the nominees of the Minister of Education, if he shall reside within 50 miles of Manchester, shall be one; two shall be professors other than the principal elected by the senate from their body; the eleventh and twelfth shall be the treasurer and the principal.

The members of the council, other than the president, treasurer, and principal, shall hold office for two years only from the date of appointment, but may be re-elected.

In case of vacancy arising during the term of service of any such member, if he be one of the nominees of the court, the council may fill up this vacancy by appointing any governor to the same for the remainder of the late member's term of office. If he be one of the two professors, the senate may make their appointment of a new member for his full term.

The council shall meet once a month at least during the College session, and at other times when convened by the president, the treasurer, or the principal.

Three clear days' notice of all business, except as after mentioned, to be brought forward shall be sent to every member of the council, and no meeting shall be competent to transact any other business than such as shall directly arise out of the business so brought forward, or such business as shall have arisen since the issue of the summons for the meeting, and which shall yet for the satisfactory working of the institution require immediate determination.

The quorum necessary to constitute a meeting of the council shall be seven, and a majority shall carry any resolution, except in the case of a resolution for the removal of a professor, which shall only be carried by a vote of at least eight members of the council. The chairman of the meeting may vote and may have a second or casting vote.

If the treasurer and the president be absent the members of the council present being a quorum shall appoint a chairman for the meeting.

The Council shall

- (1.) Manage the financial and ordinary affairs of the College, and annually report to the governors thereon.
- (2.) Keep the record of, and see to the due maintenance of the lists of the members of the council and the associates, and the registers of students.
- (3.) Direct the affixing of the College seal.

(4.) Appoint the principal and professors and make contracts with them; and before proceeding to the election of a professor the council shall in ordinary cases advertise for and receive candidates' applications and testimonials, and shall refer the same to the senate for examination, arrangement, and report, but the council shall not be obliged to adopt the report, or be bound by the recommendation of the senate. In special cases, and after having applied to the senate for information, the council may, subject to the approval of the court, appoint to a professorship without advertisement.

(5.) Appoint the registrar, the treasurer's clerks, and other officers and servants of the College, and regulate their remuneration, with power to remove them.

(6.) Control and direct the management of the libraries and museums connected with the College.

And shall have power

(7.) To license halls and lodging-houses, and make such regulations as it may think fit for their proper management.

(8.) To receive from the senate suggestions and statements of business transacted by them, and suspend, if they think fit, any rule or resolution passed by them, until the pleasure of the court respecting the same shall have been ascertained.

(9.) To fix, and from time to time vary, the fees to be paid by students, with power to dispense with, remit, or compound for, the payment of fees by any particular student or class of students.

(10.) To expel offending students.

(11.) And shall discharge such other functions as the court may from time to time commit to it.

#### THE PRINCIPAL.

The Principal shall be the chairman of the senate, and its representative on the council and the court. In his absence the senate shall appoint a chairman of the meeting. The chairman may vote, and may have a second or casting vote. The principal need not be a professor in the College.

#### THE SENATE.

The Principal and whole body of Professors shall form the Senate, and shall meet at least once in each month during the session.

The senate shall, subject to the control of the council, discharge such functions in reference to education and discipline as the court may by bye-laws or regulations assign to it, and in particular shall (subject as aforesaid):

(1.) Fix the hours of the classes, and arrange the subjects of instruction and examination, and frame regulations for the conduct of classes and examination.

(2.) Fix, subject to Founders' regulations (if any), times and mode and conditions of competition for scholarships and prizes.

(3.) Regulate the admission of students, and keep and furnish to the registrar class lists, and maintain the ordinary discipline of the College, with power to suspend any offending student.

(4.) Appoint and dismiss any tutors or occasional lecturers.

All resolutions passed, appointments made, and rules framed by the senate, shall be laid before the council at its next meeting, and the council may at its discretion suspend any of them till approved by the court.

Any professor aggrieved by any act of the senate may appeal against the same to the council, who may, if it think fit, sustain the appeal, and refer the matter to the decision of the court.

#### REMOVAL OF PRINCIPAL OR PROFESSORS.

The Principal or any Professor may be removed from office only in the following manner:—

The council may (upon a month's notice of motion having been given to each member of the council, and also to the principal or to the professor in question) by a vote of not less than eight members, resolve that it is expedient to remove a professor, and declare when his appointment shall cease. A copy of such resolution shall forthwith be delivered to the principal, or to the professor as aforesaid.



A month shall be allowed to such principal or professor from his receiving a copy of the resolution of the council, during which he may appeal to the court, and if he does not appeal, or if, on appeal, the court shall, by a vote of not less than 10 members, confirm this resolution of the council, his chair shall, according to the terms of the resolution, become *ipso facto* vacant, but if such principal or professor appeals, and the court decides against his removal, he shall retain his chair.

#### LEGISLATION.

A. The Court shall have power to make byelaws for the government and administration of the College, which are not contrary to the provisions of this Act. No byelaw may be proposed without at least one month's notice of the intention to propose it being primarily given to the council, unless the proposal originates with the council, and is accompanied by their report.

B. Changes in the constitution of the College, which are not contrary to the provisions of this Act, may be passed by the court upon the recommendation of the council, and shall then be laid before Her Majesty in Council, for approval, and when so approved, shall be adopted, and be subject to alteration in like manner.

#### THE ASSOCIATES.

The Court shall at any time have power, on the recommendation of the council and with the consent of the senate, to fix the conditions on which persons who have been students, may become Associates of the College, and such associates shall have the right of appointing in such manner as the court may direct, three members of the court, and shall have such other privileges in connection with the College (not inconsistent with its fundamental laws) as it may direct.

#### THE THIRD SCHEDULE.

##### Names of First Life Governors.

Thomas Ashton	- Manchester	Merchant.
John Marsland Bennett	- Manchester	Timber Merchant.
Charles Frederick Beyer	- Gorton, Manchester.	Engineer.
William Romaine Calder, the younger.	- Manchester	Merchant.
Richard Copley Christie	- Manchester	Esquire, Barrister-at-Law.
Robert Dukinfield Darbishire.	- Manchester	Solicitor.
The Reverend Nicholas William Gibson.	- Manchester	Clerk, one of the Canons of Manchester.
Murray Gladstone	- Manchester	Merchant.
Edward Hardcastle	- Manchester	Merchant.
Oliver Heywood	- Manchester	Banker.
Wm. Henry Houldsworth	- Manchester	Cotton Spinner.
Richard Johnson	- Manchester	Wire Manufacturer.
John Lawson Kennedy	- Manchester	Calico Printer.
Alfred Neild	- Manchester	Calico Printer.
Herbert Philips	- Manchester	Merchant.
John Robinson	- Manchester	Engineer.
Sigismund James Stern	- Manchester	Merchant.
John Edward Taylor	- Manchester	Newspaper Publisher.
Joseph Thompson	- Manchester	Manufacturer.
Sir Joseph Whitworth, Bart.	- Manchester	Engineer.
Matthew Alexander Eason Wilkinson.	- Manchester	Doctor of Medicine.

7274. (*Mr. Samuelson.*) Have you received a reply from the Privy Council to this last Memorial of yours?—We have received no formal reply.

7275. (*Chairman.*) That application, I believe, was sent in about the time that this Commission was being formed?—I think it was about the same time.

7276. (*Mr. Samuelson.*) Was not the application for assistance towards the salaries of the professors confined solely to the professors in the science department?—Yes; I do not know what is the cause of the tacit assumption which I find everywhere obtains that any aid given by the Government in future to academical bodies, must be to the science part. Whether it is because the science departments are the only ones which deal with material progress, or whether it is considered that the old endowments are available for the old academical subjects, and that the balance may be redressed by giving Government aid to the new subjects, I do not know, but we thought it was safest on our part to acquiesce in the common hypothesis.

7277. Was not the application for a definite sum of 300*l.* a year for each of the seven science chairs?—Yes.

7278. You probably had in view some definite sum which you thought those salaries ought to amount

to from various sources?—Yes. We thought that 500*l.* a year was not an unfair amount of stipend to each professor who gives the whole of his time to the work of the department.

7279. Should you consider yourselves at liberty to devote a larger proportion of the general funds belonging to the College to the arts professors, in case the Government had consented to assist the science professors?—That question has never been raised. The disproportionate figures which I just now laid before the Commission, would show, I think, that it would not be unfair to take some steps towards equalizing the sums allotted to the two departments. A very large proportion of the amount set free by any grant from the Government would certainly go to add to the working efficiency of the College by the provisions of more skilled assistance and manual service in the laboratories. I am giving this simply as my own opinion on the question. If it were thought fair to the public interests to stipulate that there should be no deduction from the amount supplied from the Owens funds towards the science side, we should probably have no hesitation in undertaking to raise from other sources any additional payment to the arts side.

7280. It probably would be considered decidedly objectionable that there should be a great disproportion in the salaries received by the science professors, and those received by the professors of literature and arts?—Yes.

7281. (*Chairman.*) Have steps been under consideration for revising and extending your scheme of studies?—Yes. We wish more particularly (I speak of science now, of course, alone) to have two new chairs. We wish to found a chair of mining and applied geology, and we wish to divide our Natural History chair, which is now a single chair, into at least two. It will be obvious to the Commission that the first chair named by me, that of mining and applied geology, is one of particular importance to the district in which Owens College is placed. It is almost a scandal to the College itself that there should be no chair whatever upon a subject which is perhaps more intimately connected with the industry of the county than any other; but it is also clear that the expenses of such a department as that would be very considerable. We have recently established a special fund for the proposed department, and I think about 2,000*l.* have been already specially subscribed for this one purpose.

7282. I believe that that topic was only started within the last few months?—Not more than six months ago, I believe. Then, with regard to the natural history chair, that will be divided into at least two. We have the nucleus of the funds required for that purpose in the contingent gift of the Natural History Society, and we have already appointed a very able Curator, who is receiving a good stipend; he is at present employed principally in getting the collections into good order; but we should be glad to utilise him, so soon as the collections are arranged, by making him a kind of sub-professor or a full professor.

7283. The Commission would be glad to learn your opinions as to the relations between science instruction and technical training?—It appears to me that the main source of the defects which we all admit to exist in respect of technical instruction lies in this—that those great branches of manufacturing industry which rest, in a greater or less degree, on a scientific basis have been (as was to be expected) much more slowly recognised as *liberal professions* in England than on the Continent. It is of course quite true that the most eminent engineers, for instance, civil and mechanical, being almost always men of excellent natural parts, and attaining to great wealth, rapidly acquire high social position and great influence. But these are given to them as *individuals*; and the result is not, save in a very slight degree, to raise the *status* of their professions as such, which are continually entered by men who are inadequately fitted to practise

J. G. Greenwood, Esq., B.A.  
31 March 1871.



J. G. Greenwood, Esq., B.A.  
31 March 1871.

them. If in these, and other great scientific professions, the scientific basis were recognised as the indispensable preliminary to the professions, all this would be different. It would be seen to be as unreasonable and inexpedient that, as a rule, men should enter such professions first through the gate of practice, as that barristers, doctors, or clergymen should do so. Again, not only do the professions suffer, and that in more ways than one, from the fact that it is not customary for young men to seek a liberal grounding in the special sciences on which the arts they are going to practise rest, but education suffers in a scarcely less degree. No one dreams of limiting the liberal teaching of our universities and colleges to the scanty fare of the earliest ages: if the academical *pabulum* had not been gradually extended by the sciences and branches of letters which have been brought in by the several liberal professions, where should we have been? It is absolutely necessary that we should from time to time take up and assimilate new applications of learning and science; and if we do not, we are no longer side by side with our pupils, and our influence over them suffers. The *omne scibile* must, with due qualifications, always be the true definition of the materials of the higher education; and those who would arbitrarily shut the door to the newer arts are, in effect, violating all academical precedent, while they think they are jealously observing it. But this jealousy is not the only extreme to be avoided; we not only have the purists of the old school, who would absolutely exclude from a place in academical instruction almost any reference whatever to the applications of science to the arts or manufactures, but, on the other hand, there is the equally mischievous extreme of those who would in fact make science the mere handmaid of the ever varying utilizations of science in manufactures and various branches of industry. I cannot help thinking that the somewhat unfortunate term "technical training" is itself responsible for a good deal of the misapprehension which exists. In a paper issued by a Committee of the Society of Arts some time ago, a committee appointed to consider this very question, a definition is given which seems to me a sound one of what "technical training" means. That committee defined the phrase "technical training" as meaning the "general instruction in those sciences, the principles of which are applicable to various specified employments of life," and as "excluding the manual instruction in arts and manufactures which is given in the workshop." If that definition of technical training be correct, I see no reason why the most jealous vindicator of the dignity of science should take offence at it. The danger to be guarded against is not so much the intrusion of what belongs to the workshop as the fragmentary teaching of science itself with a too special regard to its applications. Some time ago Professor Roscoe and I, at the request of our committee, visited the German Universities and laboratories, and we had many interesting conversations with some of the leading men of science in Germany upon this very subject. The recently deceased Professor Magnus, who was the eminent Professor of Technology in the University of Berlin, himself drew attention to the danger which he felt to be showing itself in Germany on that head. He said that he "already detects signs that the new-born zeal for teaching science in its application to the practical arts is encroaching on the domain of science proper, and that it will thus deteriorate science without at the same time advancing industry. The true work of institutions founded with the special aim of fostering the industrial arts should be to insist on teaching principles systematically, and not in their isolated applications. To treat of the applications of science is of course necessary, even for the sake of science itself; and under certain circumstances some of these applications may wisely be more dwelt on than others; but this is quite a different thing from pretending to teach as science detached fragments of science in their application to this or that art." It seems to me that the opinion of Professor Magnus

is closely in harmony with what our experience in Manchester has led us to see; viz. that, while it is quite legitimate in a given neighbourhood to lay more stress upon the application of science to this art or to that art, this must not involve the teaching fragments of science in their application to this or to that art. With that opinion of Professor Magnus we were both cordially in harmony; and the safeguard against the danger indicated appears to me to consist in two precautions, first, in selecting as teachers in such institutions men of science of the first order; and secondly, in maintaining the academical character of the institutions, and vindicating to the newly introduced branches of science their title to a university character. It seems to me, therefore, that we should most effectually guard against the mischief that everyone foresees by connecting schools of practical science with academical bodies, whose constitution is a guarantee that they will not glide into the danger apprehended. On the other hand, it appears to me most important that there should exist some such institutions in the great centres of the industrial population; for, as I was saying in another connexion just now, we cannot hope to attract to any great distance from their homes, the aspiring and more highly endowed artizan students. First of all, we have to find them, and that requires local inquiry and local knowledge; and then, when they are found, they can hardly be, except at enormous expense, carried off to very remote places for two or three years of continuous education. For example, there exist thoroughly endowed schools of science in London, in Glasgow, in Dublin, and in Edinburgh. But these schools do not alone meet the demand. There should also be found, not in every large town, but in every very important unit of population, such a school, in order that young men of very promising parts and of high aspirations may obtain the high culture that they are fit for, without being completely separated from their homes, or cut off from all hope of partial employment or industrial occupation. We have had considerable experience in that way, owing to the great impulse given to this particular kind of study by Sir Joseph Whitworth's endowment of the Whitworth Scholarships. It is known to every member of the Commission, I have no doubt, that pending the full development of the scholarship system, Sir Joseph every year gave a large sum of money to found certain exhibitions, which were to be given, almost at the discretion of different bodies all over the country, to young men who were promising candidates for scholarships. We had a large number of these exhibitions, five, or six, or eight, in different years, put into our hands, and by advertising in the papers we got a good number of young men from all sides to compete for them. They were examined in the ordinary way, and they were required, by the course that we adopted, to spend a year in studying in our College for the scholarships themselves. At the same time we remitted their fees, so that they were able to live on the amount of the exhibitions; and, at the last award of scholarships, three or four of those artizan candidates were elected, who could hardly have been discovered and educated so cheaply under any other system. But now that that system of exhibitions of 25*l.* has come to a natural end, we have no means of getting hold of the same class of young men as we had; for we have not the means upon a large scale of educating them gratuitously. At the same time, the experience of those two years does lead one to regret very much that we have not the opportunity of carrying on the like service from year to year.

7284. (*Mr. Samuelson.*) Are you aware that the Science and Art Department offer exhibitions of 25*l.* a year in consideration of a similar amount contributed by the localities?—That was the case some years ago, but that minute, I believe, has been withdrawn.

7285. Are you not aware that it is stated in the Science and Art Directory, at page 19, that "the Science and Art Department will make a grant of 25*l.* per annum to the managers of any school or educational institution, or any local committee, formed for



"the purpose, who will raise the like sum by voluntary contribution for the maintenance of a student at some college or school where scientific instruction of an advanced character may be obtained. The exhibition may last for one, two, or three years?"—There must be some misapprehension about it, I think. In the first year of the Whitworth Exhibitions, I applied for the application of this minute to the men who held them, and they got 25*l.* In the second year I made the same application for working men,—one man, I think, who had 25*l.* from Sir Joseph Whitworth (a 25*l.* Whitworth exhibition), and the reply which I got was that the minute had been withdrawn under which that grant was made. [The minute which was withdrawn was, I find, a special minute under which the Whitworth Exhibitions were treated as "local contributions of 25*l.*"]—J. (G. G.)

7286. What you would really require in your case would be that some local contributions of 25*l.* should be obtained in order to call forth the grants of 25*l.* from the Science and Art Department?—Yes, we should be most glad to avail ourselves of that minute, and to meet the contribution from the Department by remitting the fees of artizan students; but we could not remit the fees and raise local contributions of 25*l.* at the same time.

7287. (*Chairman.*) Have you among the 261 students in the present session any that could be considered as belonging to the artizan class, except those who have obtained assistance from Sir Joseph Whitworth's Exhibitions?—Yes; we have one or two free artizan students who held Whitworth exhibitions in a former year. We have also men coming to our day classes who are holders of a certain scholarship called the Rumney Scholarship,—a most admirable scholarship founded by Mr. Alderman Rumney, who offers 50*l.* a year for three years to any artizan candidate who shall have gained the highest aggregate number of marks over a space of three preceding years in the Government Science and Art Examinations. Mr. Rumney's original hope, I think, was that the Rumney scholar would also obtain the grant of a 50*l.* Royal Exhibition from the Department, but it was found that, in order to allow of that, he must hold the Scholarship in Jermyn Street or in Dublin. It so happened that the very first man who was entitled to hold the scholarship preferred to hold it in Owens College, but it was discovered that that would not be compatible with the regulations of the grant from the Department; and therefore he had either to alter his plans or to forego the advantage of the additional grant. As it happened, being a Manchester man, he thought that the addition of 50*l.* would probably not do more than cover the additional cost of living, and therefore he determined to hold his scholarship at Owens College. For the future Mr. Rumney has made it a condition of his scholarship, that the man must hold it in Owens College, we, on our part, remitting the fees payable. Thus we shall, in future, have really competent artizan students coming to us from the Mechanics' Institutions of Lancashire or Cheshire. I am happy to say that the examination for this scholarship, I mean the conditions of the award, are of a very stringent kind. For instance, the man who won this year's Rumney scholarship was also a Whitworth scholar in the previous spring, and he was not allowed to hold the two in combination. The Rumney scholarship, of course, lapsed. It might have been supposed that, wishing to make the foundation available to a large number of persons, the electors would have given it to the next best man on the list, but it was concluded that the next best man was not up to the standard of the Rumney scholarship, and therefore no award was made.

7288. Of what classes should you say that your students are chiefly composed?—Of the day students, in the current session, I find that exactly one-third are sons of members of the professional class of all grades (clergy, lawyers, medical men, teachers, and public officials); about two-fifths are sons of members of the higher mercantile class (merchants, manufacturers,

shippers, &c.), or of persons of independent means; the remainder, for the most part, belong to the lower mercantile class; and there are among them a few artizans.

7289. Are your students entirely the sons of persons resident in Manchester?—By no means. A very large number, I daresay two fifths, come in every day by the railways—from the north, south, east, and west.

7290. From the surrounding districts in Lancashire and Cheshire, and even Yorkshire, should you say?—Yes, principally; although at the same time some have come from much more distant parts, some from the north-eastern district, Newcastle and Durham; some from the eastern counties, Norfolk and Suffolk; some few from the Midland districts, and so on.

7291. (*Mr. Samuelson.*) Are you speaking now more especially of science students?—Yes. I think it is more true of science students than others.

7292. (*Chairman.*) With respect to your evening classes, have they been a success?—In the point of view of numbers, a very great success. There are now 527 in the classes; and I think that, in comparison with other evening classes, they may be also called successful in this respect, that the proportion of the men who enter for a second or third year is larger with us than in corresponding series of classes elsewhere. I find that in the present year about one-half are men who have entered for a second or a third year, and one-half are new entries for the present year. That seems to me, however, too small a proportion of former students to the newly-entered students. I was saying they are successful as far as numbers are concerned; that supposes me to imply that there is a sense in which they are not altogether successful. Our ability to systematize the evening class instruction is limited by the very serious addition to the labour of the professors which the evening attendance at the end of a long day's work involves. We are obliged, although we all of us do some evening work, to supplement our work by very valuable help given by gentlemen not attached to the College staff, masters in the Manchester Grammar School, and others. These gentlemen must be attracted solely by the wish to share in what they feel to be an important public enterprise. The income which the fees produce is so small that we cannot venture to provide from year to year so complete and continuous a course of instruction as we could wish to offer; but, perhaps, it is more important for working men, and for the corresponding classes who enter the evening classes, that they should have methodized instruction than for those who go through the more elaborate courses in the day. The difficulty arises in this way, that many classes must be held for half a dozen men, or for 8 or 10 students only. A great many most important subjects are not popular in their nature, and those classes, therefore, furnish merely a nominal sum by way of fees, so that we are not able to offer from year to year so complete an outline of study as we feel we ought to offer, because we have no endowment for those classes. That is one of the first points to which I think we should bend our efforts when we get a larger sum of money to employ in that way. Professor Huxley has lately offered to our consideration an extremely valuable system of evening class instruction, showing how, in a two years' course, it would be possible to give to a well-prepared evening class of students a real insight into science as a whole. Nothing would be more desirable than to carry into operation such a scheme as Professor Huxley offered to us. The one difficulty lies in the scanty funds at our disposal for giving a moderate payment to the gentlemen whose services would be called into requisition.

7293. (*Professor Huxley.*) I gather from what you say that you do not think that payment upon results offered by the Department would be sufficient to cover the expenses of such teaching?—I am inclined to think it would not, and for this reason, that it would not be worth our while to develope a system of the kind,

J. G. Greenwood, Esq., B.A.

31 March 1871.



J. G. Greenwood, Esq., B.A.  
31 March 1871.

unless we were to do it on what we believed to be the soundest scientific principle, regardless of the accidental popularity of this or that subject; and we might therefore take up such a line, both as to method and as to subject-matter, as would not always be most effective for getting the payment by results. It would repeatedly happen that men who were going in for payment by results would say, "This will not pay so well as that," and therefore payment by results would inevitably lead to undue payment for one subject, and inadequate payment for another subject.

7294. (*Chairman.*) Are the evening classes attended almost exclusively by men of the working classes?—If you include under the words "working classes" not only artizans, but warehousemen and clerks in offices, I should say not quite exclusively, but probably to the extent of five-sixths.

7295. Will you be so good as to state to the Commission your view as to the best training of teachers?—I think that the best training of teachers is to be found in the opportunity of studying under good professors of the several subjects to be learnt by them. The teaching in an exclusively normal college, whilst of course it has under certain conditions great advantages, has also very great defects. The same objections which are taken, not without reason, to special theological colleges, for example, would also hold with respect to special training colleges for science teachers. On the other hand, there is great advantage to be derived from a training in *method* for such men; and there is an obvious way of combining these two things, namely, the best and most thorough training in science itself, and a short course on method, if it were understood to be the practice in all colleges, such as University College, King's College, Owens College, and others, that the professor of this or that subject, whether of classics, or mathematics or of some branch of science does not matter, to hold, towards the end of each session, a small special class for the men who were to be teachers ultimately; something, in fact, very much like the well-known *seminarium* of the German Universities. If, for example, there were 10 men in my class of Greek, and 20 men in Professor Roscoe's class of chemistry, who made known their wish to be teachers of those subjects respectively, we might hold, in the last two months of the session, a small class for them in a way that should make the lectures, so to say, model lectures, and in which again the more advanced of those 10 men, perhaps five of them, might themselves, under our inspection, give typical lessons to the less advanced members of the same class. That, I think, would be a thing perfectly easy to do, and would combine the best points of both methods of training.

7296. Would you, to a certain degree, think it advisable that teachers should be trained by assisting the professors, or by giving lectures under their direction?—I think it would be good to do it, but I would do it in small classes. I think, for example, it would be a very good thing if there were, in every year (and I think this is the custom at Heidelberg in the classical *seminarium*), a higher and a lower teacher's class, and the members of the higher class were to give lectures to the members of the lower class. I do not think it would be compatible with the best interests of ordinary students to allow novices in teaching to make trial upon them, as on *corporalia*, but I think it would be quite possible for the three or four more advanced future teachers to lecture, under the professor's inspection, to 9 or 10 less advanced.

7297. Have you considered the question of the relation between the Universities and other institutions for the higher culture and elementary schools?—On this large and very important subject I beg leave to refer to § V. of a Report of a visit which Dr. Roscoe and I made officially to many of the German Universities and Polytechnic Schools, and a copy of which will be put in by Dr. Roscoe. I should like to add that, while it would be a serious mistake to call upon institutions for the higher culture to do any of

the work of elementary schools, except possibly by way of direction and examination, it appears to me that, by means of a gradation of schools and the provision of a sufficient number of small exhibitions, it would be practicable and most desirable to enable the choicer spirits among members of the less wealthy classes to find their way into colleges and universities. To do this would be in harmony at once with the spirit of the mediæval university system and with the tendency of our own most recent legislation. We have done a little in this way in Owens College, by holding out exceptional facilities to artizan students; but such efforts need to be extended and systematized.

7298. (*Mr. Samuelson.*) You have put in your subscription list; is it the case that the funds for the various purposes contemplated by the extension of Owens College have been contributed by comparatively few individuals, or are there many subscribers?—The fund is considerable, but at the same time far more than one half of the whole sum has been subscribed by a few individuals. The Chairman of this Commission, who is our President, has given 2,000*l.*; Mr. C. Beyer, the engineer, subscribes 5,000*l.* or 6,000*l.*; more than 30 persons have subscribed each sums of 1,000*l.* or 2,000*l.*, and a large proportion, about three-fourths, of the whole is in sums of 500*l.* and upwards.

7299. My reason for asking the question was because I was anxious to ascertain whether public opinion had been awakened in your district to the importance of such an institution as Owens College?—I think it has; but at the same time it is proper to add that no organized attempt has yet been made to collect the smaller sums, which we shall doubtless be able to collect when we make that attempt.

7300. Is it your opinion that of late years public opinion in Lancashire, and more especially in Manchester, has inclined towards the increased scientific education of the industrial classes, including in that term employers as well as artizans?—Yes, I think that that tendency has shown itself.

7301. I believe that you require a large portion of your extension fund for the purpose of paying for the site which you have acquired?—Yes, 30,000*l.* is the cost of the site alone.

7302. Is that site in any central part of Manchester?—Not very central; if it had been very central the cost would have been 130,000*l.* or 150,000*l.* We have four acres of land within about one mile from the centre of Manchester, and very accessible from all parts.

7303. Are there at this moment, or have there been, any buildings upon that land which must be pulled down in order that the erection of your College may take their place?—Yes.

7304. Would it not have been possible, within a short distance of that site, to have obtained land not having buildings upon it, and consequently upon more economical terms?—Within half a mile or three quarters of a mile, such a site was, in fact, when we had completed the purchase of this site, offered to us, or rather brought to our attention; but in the first place we had completed the purchase of the site in question, and had prepared the plans for building on it; and, secondly, the essential condition of a good frontage to a leading line of approach could only be secured by a costly and tedious process of purchasing fresh land in addition, or of getting parliamentary powers.

7305. In fact, you would have no difficulty in justifying the large sum which you paid for the land as being upon the whole a judicious investment of money for the purposes of the College?—I think so; and on this ground, among others, that since many of our most important supporters live in towns north of Manchester, every quarter of a mile further from the Victoria Railway Station, which brings persons in from those towns, would have seriously added to the difficulties which those outlying towns would have had in making use of our institution.

7306. And your fixing of the site was generally approved, was it not, by those who have been im-



portant contributors to the existing fund?—Yes, with one or two important exceptions; and nothing was more unwelcome to the committee at large than to be compelled, in obedience to what they thought their better judgment, not to listen to the strong wishes which one or two of our committee expressed for a change of site; but there will always be differences of opinion upon such points.

7307. But if the Treasury were unfortunately to object to an application for a grant on the ground that you have spent unnecessarily large sums upon land, you think you would have no difficulty in justifying that expense?—I have no doubt of it.

7308. (*Marquess of Lansdowne.*) I think, in the minute of your Committee which has been put in evidence, you lay down the principle that State aid to education establishments should be granted upon certain conditions, of which there are five?—Yes.

7309. Was it the intention of your Committee to limit that principle to institutions where the education was of a scientific character, or would you extend it to all educational institutions?—We were only concerned with scientific education when the minute was made, because the application referred to that only, but I think that the principle is theoretically applicable to other educational institutions. [See also Q. 7276.]

7310. And your Committee also stated that they anticipated that the co-existence of those conditions in your institution would go rather to make such applications for State aid correspondingly rare?—We thought so.

7311. Should you think that in any of the very large manufacturing towns of England it would not be proper, taking into consideration the rapid growth of science in these days, that such institutions should be formed, and such claims should be made upon the State for aid?—Efforts have been made very recently, I believe, both in the West Riding and in Liverpool, but in neither of those cases, so far as I am aware, has any response of much moment been made to the local appeal.

7312. But, supposing the principle to be admitted that the co-existence of those conditions establishes a claim on the part of the institutions, do not you think it is extremely possible that in future years a large number of such institutions may grow up, each having a claim of that kind based upon such conditions?—In the course of a generation or two it may be the case, but not, I think, all at once.

7313. Therefore, you think that all the objects might be accomplished, and the principle might be affirmed without any very considerable calls, within a reasonable number of years, upon the public exchequer?—Yes, I think so.

7314. As to the second of those five conditions which were enumerated, namely, that the institution in question should be materially endowed by local funds, should you adhere to that strictly, because would it not be the case that if an institution were struggling into existence, and the local funds failed, that very circumstance would almost afford an additional argument for the State doing something for it?—On the other hand, if it were known that Government aid would be forthcoming in case of liberal local subscriptions, I think the absence of the subscriptions would show that there was not in the mind of competent judges any great need for the institution.

7315. You would say from your experience that public opinion might be fairly depended upon for procuring a sufficient quantity of local aid to justify corresponding aid from the Government?—Yes.

7316. With regard to the possibility of those demands growing to any great extent, would you not say that it would be fairer, perhaps, to limit the application of the principle in some such way as this, that the country might be divided into educational districts like military districts, and that there should be so many recognised centres of education of this kind, so that there might not be within a limited area an unlimited number of applications for help cropping up on every side?—Yes; and it appears to me that we

must throw the duty upon the Government (if they do not shrink from the responsibility) of defining those areas.

7317. (*Sir John Lubbock.*) If the effect of such a grant as is applied for by you were to elicit corresponding help, liberal subscriptions, and active exertion in other great manufacturing centres, do not you think that that would in itself be a very great advantage?—I think it would. I was merely desirous to point out that there would not be a sudden rush of applications.

7318. (*Mr. Samuelson.*) What you would probably expect on the part of the Government would be rather that they should fix the areas than the centres of those areas?—Yes.

7319. (*Professor Huxley.*) Did I rightly understand you to say that you thought it desirable that there should be a common culture for all the students in Owens College, in part literary and in part scientific, so that no literary student should pass out altogether ignorant of science, and that no scientific student should pass out altogether ignorant of literature?—Yes, that is my view.

7320. I understood you to draw a very proper distinction between literature and philology. Literature is literature, and philology is a science. Do you include philology in your idea of literary training?—I confess that although it is unscientific to do it, I do.

7321. To what extent do you go? Do you think that the study of Greek, from a philological point of view, is essential to a thorough literary culture as far as it goes?—It appears to me very important to include both Greek and Latin; Greek, as being the fountain-head of all European literature, and Latin, as the mother of several living languages, and, therefore, at once supplying a key to the acquisition of these languages, and being itself, by reason of this connexion, an admirable instrument of philological training. I am of opinion, too, that, by an improvement of our method of teaching, both languages might be studied to an adequate degree without too great a sacrifice of time. At the same time, I admit that, in the case of a student of science primarily, some one classical language would answer the purpose of culture, although not very completely answer it.

7322. You would be satisfied, would you, if such culture were confined to the Latin language?—To Greek or Latin in the case of a student who, being a science student primarily, had but little time to give to those studies.

7323. Do you think it quite impossible that a thorough literary training, as far as it goes, might be given by a careful study of the English language and literature?—I am inclined to think it is impossible, partly on *à priori* grounds, and partly on grounds of experience. I think on *à priori* grounds it is probably impossible, because the great familiarity which a young student has with the English language prevents him from looking at it objectively, and consequently he would hardly be persuaded in the short time that he has to devote to it to put himself sufficiently *outside* of the subject, if I may so express myself, to get any scientific or even literary culture, of much value, out of it.

7324. That would apply rather to the English language as an instrument of philological study; but might it not be possible that a student should acquire a very much better conception of literary beauty by a thorough study of his own language than by what commonly passes under the name of Greek and Latin classical study?—I would not like to say that it is impossible, but I do not think it has yet been done. I do not think we have yet seen, on a large scale, a play of Shakespeare treated like a play of Sophocles, and made to the young student as valuable a means of literature culture.

7325. Has it occurred to you that persons who are very well cultivated in the Greek and Latin languages sometimes write and speak their own language very badly indeed?—I have known some instances of this.

7326. So that proficiency in Greek and Latin is no test of the literary sense being applied to one's own

J. G. Greenwood, Esq., B.A.

31 March 1871.



J. G. Greenwood, Esq., B.A.

31 March 1871.

language?—I do not know that that follows, but it sometimes is so.

7327. After all, is not one's great object in literary culture to be able to use one's own language?—Yes; at all events this is one, and a very important, object; and I think that many of our best living speakers are also most excellent classical scholars.

7328. You have spoken of the seminaria in the German Universities. As an ordinary rule, do the students who are trained for teachers in those seminaries have any opportunity of practising, so to speak, upon a class?—At Heidelberg I had a long interview with Professor Köchly, an eminent Greek scholar and the Director of the Classical Seminarium in that University; he informed me that there are two sections, the upper and the lower, and that the members of the upper section take a part in the instruction of those in the lower section.

7329. Is that generally the case in the German seminaria?—I am not prepared to say. I think that it was not the case in science, certainly, and I think not the case generally in classics.

7330. Do you think it essential that students being so trained should be able to practise upon *corpora vilia* of that kind?—I think it so desirable that, under the limitations mentioned by me just now, I should make great efforts to put it into practice myself if I had the opportunity.

7331. (*Sir J. P. Kay-Shuttleworth.*) Would there not be considerable opportunities afforded for the practice of teaching of science particularly in classes connected with the several institutions in Manchester, to which students could resort, and where they could practice teaching somewhat under the eye of the professor?—If there were anything at all in the nature of a gradation of schools, which I should very much like to see, that might be done, I think, with great effect.

7332. It might be even extended to the literary classes, might it not, if there were such a gradation of schools as is contemplated by the Endowed Schools' Commission?—I think so.

7333. Of course special arrangements would have to be adopted if that instruction were to be conducted under the eye of the principal, or of one of his assistants; but if sufficient assistance were given to the principal, do you apprehend that there would be any difficulty in giving that practical instruction in the art of teaching in such institutions?—All would depend upon that. It would, no doubt, increase enormously the work of the professors, and it would therefore require an elaborate system of assistants, but with that qualification I see no difficulty.

7334. Supposing that a considerable demand arose for school teachers, whether of literature or science, such as would obtain their instruction in a college like Owens College, might it not be a wise expedient to appoint a Professor of Method in connexion with such a College, who should be in immediate communication with the professors of literature and science, and should be more responsible than they are for the guiding of students in their practical instruction in such classes as I have already adverted to?—It would be an experiment of great value to make; but I think there is room to doubt how far a Professor of Method, who is not himself engaged directly in teaching this or that special subject, would throw life enough into his illustrations to enable him to be an effective guide.

7335. But if a part of the function of the Professor of Method were also to assist, we will say, the science professors, he might naturally make his own instruction in method entirely in perfect harmony with the instruction given by the professors?—Yes.

7336. And so, a Professor of Method might be connected with the literary studies, supposing all questions as to funds were solved?—Yes, with this one qualification, that I should like the Professor of Method to be under the direction of the professors of the special subjects, and not *vice versa*—the Professor of Method to be superior to the other professors.

7337. You would desire that the Professor of Method should be an assistant to the science professors on the one hand, or to the literary professors on the other?—Yes.

7338. Supposing, therefore, that the Commission were convinced that there was great need for a considerable increase in the number of more highly instructed teachers of science or of literature for the several grades of schools contemplated, and that it was an indispensable part of their training that they should have a good knowledge of the method of teaching, and some practice in the art, would not such a college as Owens College, Manchester, be a fortunate centre for the instruction of such teachers?—I think so, and for this reason, that, as I was saying just now, a very much larger proportion of the teaching that is taken cognizance of by the Science and Art Department is done in our district than the mere figures of the population would at all lead one to expect.

7339. You are of course well aware that in Lancashire there is a larger number of science classes under the Department of Science and Art than in any other similar area in England?—Yes.

7340. Consequently, it would be very easy, would it not, seeing that Manchester is the centre of a great network of railways, for young men, desirous of such cultivation, to resort to Manchester both for instruction in the theory of science and in the art of teaching?—Yes.

7341. And in literature in the art of conveying literary instruction?—Yes.

7342. (*Professor Stokes.*) You stated that several of your students went up to the London University; do many go to the older Universities?—Not many. Every year a few of our best men go to the older Universities, but many more to the London University. For instance, twice lately the Rector of Lincoln has nominated students of ours to a Natural Science exhibition in Lincoln College; and these men would serve as an illustration of what I meant when I spoke just now of the value of combining literature and science teaching for the same students. One of them was destined for the bar, and the other for medicine, and both of them in Owens College studied classics on the one hand and experimental science on the other; and I think they are good illustrations of the value of the combination of the two studies to make a good style of man. Again, the Senior Wrangler this year was an ex-student of Owens College, and other wranglers have of late years gone from us to Cambridge; still the number is comparatively small.

7343. Can you account for the number being so much smaller than that of those who go to the London University, since the older Universities have endowments to offer, which the London University has not?—There is perhaps some ambiguity in the meaning of the word *University* when applied to the older and to the London Universities; the London University is simply an examining body; it sends down sub-examiners for degrees in Arts and Science to Owens College every year; and, therefore, "to go to the London University" means simply to sit for examination, and take the degree; it implies no residence in London.

7344. (*Professor Smith.*) When you referred to the services which Owens College might render with regard to the systematic training of schoolmasters, had you in your mind the elementary schoolmasters, or the schoolmasters of the principal middle-class schools, or still higher schools?—I had in view chiefly the elementary schoolmasters, because the connexion which they have with the Science and Art Department would make it possible for us to enter into relations with them, whereas the schoolmasters of the middle or higher class are not organised, so that any action upon them would be simply individual.

7345. Do you find that any of your pupils do become science schoolmasters in middle class schools?—Yes; we have had two or three instances of late years. Within a few years the newly-established science department of the Manchester Grammar School, for



example, has received its chief master from among our Dalton scholars; again, the other day, the professorship of chemistry in the Andersonian University was filled by another of our Dalton chemical scholars; and last year, when Dr. Debus left Queenwood, the vacant place was again filled by an Owens College science student. Thus we have, in the course of a few years, seen most important posts filled by our men.

7346. Do you expect that you will have necessary applications made to you to find persons qualified to fill such posts, perhaps not such important posts as those that you have named, but for posts of a grade a little lower?—Yes, I think so.

7347. With regard to the elementary schoolmasters, the teaching which they would receive at Owens College would be chiefly in evening classes, as I understand?—Yes; unless they obtain scholarships of a value which will allow of their giving up a year or two to the work of training.

7348. (*Dr. Sharpey.*) You spoke of an artizan student, who had distinguished himself at Owens College, having gained a Government exhibition, which he was obliged to relinquish because it was a condition of his holding it that he should attend at the Royal School of Mines?—Yes; or in Dublin.

7349. Apart from the effect of that upon institutions such as Owens College, do you think that it is for the public interest that there should be such a restriction?—I should think not, on the obvious ground that a student of the artizan class would be less willing to leave his home and his connexions than a student of a higher class, who is more familiar with the idea of travel and migration.

7350. Do not you think, also, that it might be characterised as a monopoly in favour of a particular institution?—Yes, it certainly is a monopoly, or it may be so described.

7351. (*Mr. Samuelson.*) Have the authorities of Owens College ever considered the question whether it is desirable that they themselves should grant degrees instead of letting their students acquire degrees at the London University?—We have more than once had that question brought before our notice, and our conclusion on both occasions has been, that that was not expedient, so long, at least, as the College consisted of one sole institution. Our reasons for deciding this question in the negative were two—one, that it was not desirable that those who teach should be the sole fountains of honour for their students, and the other, that to multiply needlessly University degrees was to run the risk of lessening their value. Both in America and Germany this result has followed such a course. The London University sends down its examiners to Owens College, and does very effectually the work which we wish to have done.

7352. Does it become sufficiently well known that persons acquiring those degrees in the London

University have received their education in Owens College?—I do not know that that is sufficiently well known at present; we trust to time to make it clear.

7353. Would there be no direct way of emphasising it?—The way that I should myself wish to see adopted would be that the London University itself should from time to time hold a session in Manchester, and have its degrees conferred there by the Chancellor or the Vice-Chancellor of the University. If that were done, I think it would very much tend to promote the publicity of the degree so conferred, and be of great advantage to Owens College, and to the University itself.

7354. (*Dr. Sharpey.*) Is it not the case that the institution in which a graduate has received instruction is always added to his name in the calendar of the University of London?—Yes.

7355. And, also, is it not inserted in the general list of graduates?—Yes.

7356. (*Professor Smith.*) Has any such application been made to the University of London to give the degrees in Manchester itself?—Not in form. I have spoken of it sometimes to individual members of the Senate, but no formal application of the kind has been made.

7357. (*Sir J. Lubbock.*) Do you not think, also, that in any university giving degrees it is rather desirable that there should be a certain amount of competition between different educational bodies?—Most desirable.

7358. That would not be the case if Owens College gave degrees itself?—No.

7359. Will you have the goodness to state what the ages of the students are in Owens College?—In the present session 10 per cent. of the day students are between 14 and 16 years of age; 37·5 per cent. are between 16 and 18; 20 per cent. are between 18 and 21; and 32·5 per cent. are above 21 years of age. During the last five years, while the total number of students has more than doubled, the proportion of students under 16 has fallen more than one-half. [In the Owens College Act, 1871, power is taken to raise the *minimum* age from 14 to 15 years.—J. G. G.]

7360. You stated that you were decidedly in favour of the combination of literary and scientific studies in one institution. You would apply that to schools, I presume, as well as colleges?—Yes.

7361. You would begin with a single groundwork of general education, and then bifurcate at a later stage; that would be your idea of the best system, would it not?—Quite so.

7362. Are you prepared to express any opinion as to the earliest age at which elementary science might be taught beneficially to a child?—I have not thought upon the subject with sufficient deliberation to give an answer.

The witness withdrew.

HENRY ENFIELD ROSCOE, Esq., B.A., Ph. D., F.R.S., examined.

7363. (*Chairman.*) I believe you are Professor of Chemistry in Owens College?—I am.

7364. Will you describe the subjects of scientific instruction in that College?—A good deal of the evidence which I had intended to go into has already been given by Professor Greenwood, but I will endeavour to supplement anything that may seem to be important. We divide our students into two classes, those who go through a regular course of arts or science or engineering, and those who are termed occasional students. The majority of the students are occasional students, and the number of students of science is, as Mr. Greenwood has stated, about one half, or rather less this year, of the total number. We lay down a distinct course of study in science adapted especially for the science degrees of the London University, with which, as has been stated, we work. In the first year, the course in science and literature is identical, being the preparation for the London University matriculation. In the second year, the science course consists of

mathematics, natural philosophy, mechanics, and physics, the junior class of chemistry, and laboratory practice two days a week, anatomy, and physiology, together with French or German. I have all along insisted very strongly on the necessity of introducing the study of these two modern languages in connexion with our science course. In the third year, the science students take the following subjects:—logic, mental and moral philosophy, mathematics, mathematical natural philosophy, the senior class on chemistry, laboratory practice two days a week, geology, and botany. With regard to the fees for the science course, the first year's fees are 16*l.* 16*s.*; the second year's 23*l.* 2*s.*; and the third year's 23*l.* 2*s.* In my particular branch, especially for laboratory instruction, our fees are considerably lower than those at the Royal College of Chemistry, and lower than at some of the other London institutions. I think at the Royal College of Chemistry the fee is 36*l.* for the whole session. Ours is 21*l.* for the same time, that is the whole session of about nine

J. G. Greenwood, Esq., B.A.  
31 March 1871.

H. E. Roscoe, Esq., B.A., Ph.D., F.R.S.



H. E. Roscoe,  
Esq., B.A.,  
Ph.D., F.R.S.

31 March 1871.

months, which lasts from October to the middle or end of June.

7365. (*Professor Smith.*) For the same number of days in the week?—For six days in the week, whilst the cost of the lectures, as has been stated, is less than one half of that at the Royal School of Mines and one half of that at the other London colleges with which I have compared them. The number of students going in for our regular scientific course is naturally smaller than those who come for the purposes of what we may call technical study, for it is quite impossible for a student to become a competent

chemist unless he devotes much more time than is allowed in the science courses to the practical study of chemistry. I consider that three years' study of not less than four days per week practical laboratory work is needed to go through the chemistry course. I have prepared a list of the students attending the chemical laboratory at Owens College this session, showing their ages, and, as far as I could get to know, their objects of study or their destination in life, which I thought might be worth while to refer to, and it is as follows:—

LIST OF STUDENTS WORKING IN THE LABORATORY OF OWENS COLLEGE.—Session 1870-1.

Day Students.

Name.	Residence.	Age.	Time of Entrance.	Object of Study, or Destination.
Bury, J. S.	Arlington House, Broughton Lane	18	October 1870	—
Fuller, Arthur W.	131, Plymouth Grove	18	" 1869	Science degree.
Pickup, W. James	8, Yorkshire Street, Bacup	18	" 1870	"
Gregson, Robert	Knutsford	19	" "	—
Bedson, Peter	Bradford House, Ashton New Road	17	" "	Science degree.
Williams, W. Carleton	1, Marlborough Square, Salford	20	" 1867	Chemical manufacturer.
Haslam, W. A.	Lower Grange, Bolton	22	" 1870	—
Slater, Arthur A.	Cowley Hill, St. Helens	15	" 1869	—
Riley, John	Fairfield Road, Droylsden	21	" 1870	Chemical manufacturer.
Lacy, Thomas	Underbank Hall, Todmorden	24	" "	"
Webb, Baden	Abbey Hey House, Gorton	17	" 1869	Glass maker.
Webb, Duncan	" "	16	" 1870	"
Winser, Percy H.	Enville House, Lower Broughton	17	" "	Chemical manufacturer.
Birch, Thomas J.	Clairville, Kersal Edge	16	" "	—
Bramwell, George A.	St. Helens	14	" "	Chemical manufacturer.
Cheetham, Charles H.	Irkdale House, Middleton	18	" 1868	"
Lambert, Thomas	Middleton Road, Oldham	14	" 1870	—
Annacker, William	152, Oxford Road	17	" "	General education.
Hanson, Alfred M.	Marple	19	January "	Applied chemistry.
Ogden, John A.	Huntcliff, Dukinfield	17	October "	General education.
Carnelley, Thomas	Fernlea, Fallowfield	18	" "	Science degree.
Barnes, Josh.	Laneside Cottage, Accrington	16	" "	Student.
Ashwell, John R.	Mount Street, New Basford	16	January "	Science course.
Foxcroft, Josh. D.	Wellfield House, Cheetham Hill	18	October 1869	Dry salter.
Hopkinson, Charles	York Place, Oxford Road	15	" 1870	General education.
Jellicorse, J. H.	Willow Bank, Fallowfield	17	" 1869	Pottery.
Mickleth, J. H.	Llewellyn Street, Llandudno	19	" 1868	Chemical manufacturer.
Moir, Byris	37, Richmond Grove, Longsight	17	" "	Medicine.
Burghardt, C. A., Ph. D.	High Bank, Bowdon	23	" 1864	Ph. D. science.
Fawsitt, C. A.	6, Hulme Place, Crescent, Salford	19	April 1869	Chemical manufacturer.
Grimshaw, Harry	9, George Street, Cheetham Hill	19	May "	"
Mather, John H.	Willow Bank, Lower Broughton	20	October 1865	Calico printer.
Worrall, Henry	Whalley Range	18	" 1870	Dyer.
Kay, Henry Arthur	Haulgh Bank, Bolton	23	" 1869	Chemical manufacturer.
Goodfellow, F. F.	Lum Bank, Hyde	17	January 1867	"
Roydon, Fred.	79, Blackburn Road, Accrington	17	April 1869	Manufacturing chemist.
Eltoft, Thomas	21, Blackburn Road, Accrington	25	October 1870	Science teacher.
Westmacott, Henry	279, Markland Place, Cheetham	17	" 1869	Dry salter.
Hopkinson, Harry	3, Hyde Road	15	" 1870	—
Boyd, P.	Church, near Accrington	28	" "	Chemical manufacturer.
Newton, Walter	Park Green, Macclesfield	15	" "	—
Paterson, Peter	13, Bond Street, Manchester	Adult	" 1868	Dry salter.
Wood, Josh.	Chorley, Lancashire	27	January 1870	Dyer.
Bennett, Fred.	Birch Vale, Stockport	21	" 1869	Calico printer.
Christie, W. G.	Beaumont Street, Hull	16	" 1871	Medicine.
Holt, John H.	Birch House, Longsight	19	" 1868	Chemical manufacturer.
Roberts, Frank	Cornbrook Park, Manchester	18	" 1871	"
Townsend, George	Heath House, Pendlebury	16	" "	General education.
Wilkinson, Oswald	Dodgehill House, Stockport	16	" "	Applications of chemistry.
Holmes, Alfred	9, Lime Grove, Oxford Road	17	" "	Metal broker.
Lord, Fred.	Adamroyd, Todmorden	16	" "	—
Horrocks, Wright D.	Standish Paper Mills, Wigan	17	" "	Paper maker.
Marsh, Herbert	Rainhill	17	" "	Chemical manufacturer.
Pasley, H. F.	28, Meadow Street, Moss-side	15	" "	"
Grundy, John	Heaton Villa, Cheetham Hill	17	" "	"
Berry, Fred. Chr.	Holly Mount, Seymour Grove, Old Trafford	15	" "	Dry salter.
Wilks, John J.	Park View, Old Trafford	28	" "	Medicine.
Littlewood, William	7, Stanley Terrace, Brooklands	21	" "	—
Leese, Ernest	Glenfield, Altrincham	19	" "	—
Thomson, Murray, M.D.	Roorkee, India	Adult	March 1 "	Professor.



Evening Students.

H. E. Roscoe,  
Esq., B.A.,  
Ph.D., F.R.S.  
31 March 1871.

Name.	Residence.	Age.	Time of Entrance.	Object of Study, or Destination.
Bowyer, E. J.	Manchester	20	October 1868	Manufacturing chemist.
Oswald, John	"	33	" 1869	Schoolmaster.
Hurst, James	Sale	39	" "	Cashier.
Marsh, W.	Manchester	21	" 1870	General education; chemist and druggist.
Clifton, Jos.	"	—	" "	—
Rayner, R. H.	Stockport	—	" "	Solicitor's clerk.
Atkinson, Jos.	Sale	—	" "	Sugar refiner.
Carrick, Jos.	Manchester	—	" "	Metal broker.
Harrison, Thomas	"	—	" "	Merchant.
Goodwin, P.	"	38	" "	Soap maker.
Bailey, A.	"	31	" "	Schoolmaster.
Heywood, E.	Middleton	29	" "	Calico printer.
Shorrocks, J. H.	Salford	23	" 1869	Chemical manufacturer.
Berrie, R. M. M.	Manchester	18	" "	Dyer.
Procter, G.	"	—	" 1870	—
Reddish, A.	Patricoft	23	" "	Chemist and druggist.
Bennett, H. C.	Leigh	—	" "	—
Garrett, G. W.	Manchester	—	" "	Schoolmaster.

7366. (*Chairman.*) Can they attend the chemical laboratory without possessing any general scientific culture?—Many of my students come to the laboratory wholly unacquainted with the science of chemistry. I have to begin with the majority entirely from the beginning (in fact I rather prefer to do so), but I always insist upon their having attended, or upon their attending, at the same time, the class on theoretical chemistry. I also may put in a paper showing the number of students attending the chemistry classes since the foundation of the College, from which it will be seen that the necessity for the practical study of science is well recognised; and this is so much the case, that we have, as has been already stated, founded now a physical laboratory under Dr. Balfour Stewart's direction, and I hope to draft into this laboratory those of the senior chemistry students who have already learnt what experimentation means. These men will then appreciate the value of the exact and delicate methods of physics which will be brought before them. The list is as follows:—

NUMBER OF STUDENTS attending CHEMISTRY CLASSES,  
OWENS COLLEGE.

—	Day.			Evening.		
	Lectures.		Labora- tory.	Lectures.		Labora- tory.
	No. of Courses	Stu- dents.		Courses	Stu- dents.	
1851	1	13	—	—	—	—
1851-2	1	18	17	—	—	—
1852-3	1	18	12	—	—	—
1853-4	2	19	22	—	—	—
1854-5	2	21	20	—	—	—
1855-6	1	17	18	—	—	—
1856-7	3	35	15	—	—	—
1857-8	1	11	15	1	23	—
1858-9	2	26	23	1	16	8
1859-60	1	20	24	1	17	8
1860-1	2	36	21	1	26	10
1861-2	2	39	22	2	41	11
1862-3	2	50	34	2	37	6
1863-4	4	79	38	1	26	9
1864-5	4	100	49	2	42	13
1865-6	2	50	41	1	22	5
1866-7	3	72	37	1	33	5
1867-8	3	96	44	2	56	8
1868-9	—	142	57	3	125	7
1869-70	—	148	51	3	87	10
1870-1	—	195	60	3	64	18

7367. Do you agree with what Professor Green-wood has stated as to the relations between scientific culture and technical training?—I do entirely. I think that the definition which he has given is a very

fair one, and I think that the thing to secure is a proper foundation of sound scientific principles. This is, I believe, our first duty, and then it is easy to add such knowledge of those portions of science which bear upon manufactures as may be of importance and value to the student; but I deprecate altogether the idea of teaching (as some people seem to think it possible to do) the arts or manufactures themselves. It not unfrequently happens that the fathers of in- tending students come to me and say, "I wish you to teach my boy the principles of calico printing," or, "He is going to be a calico printer, and I want him to learn the applications to that particular trade or calling," and I always answer that I can teach them chemistry, upon which their art or manufacture is founded, which is the first thing for them to direct their attention to, without any regard to the application to special industries. When this has been accom- plished, the attendance on courses on chemical tech- nology, such as I deliver every year, are of great value.

7368. With respect to buildings, at present, your accommodation in the way of a chemical laboratory is insufficient, is it not?—It is altogether inadequate. The present building was built to accommodate 35 students, and now I have 78 working in that place; 60 in the day class and 18 in the evening class.

7369. In the building now in progress, has pro- vision been made for a suitable laboratory?—Pro- vision has been made for a very much larger, and, as I hope, a very complete laboratory. I perhaps may be allowed to show the Commission plans of the new building; and I can also give them the approximate cost of certain portions with which I have to do. I have in the first place a block plan, showing the situa- tion of the land which we have bought at a cost of 30,000*l.*, and the buildings which we are about to erect, and also indicating the buildings which we intend constructing when we afterwards complete the scheme. This (*pointing to the plan*) is the frontage of Oxford Road, and we are building the portion of the building which is coloured in deeper pink, standing at a distance of about 200 feet from the road, and it is built in such a way that in future the quad- rangle can be more or less completed by those build- ings which are coloured in a light tint. This building will accommodate a very considerable number of students; but we hope that in time those other por- tions of the necessary buildings will be erected. This building (*pointing to the plan*), I may state, is intended to be the Natural History Museum which has been mentioned by Mr. Greenwood. The building shown at the back is the chemical laboratory, and at this end the chemical theatre, the department with which I have specially to do. I have brought also a photo- graph of the elevation of the present front. The



H. E. Roscoe,  
Esq., B.A.,  
Ph.D., F.R.S.  
31 March 1871.

approximate cost of the new buildings, that is to say, the present contract, which does not include fittings, is 58,000*l.* Of the laboratory, of which I have the plans here, the approximate cost is 12,000*l.*, and that of the chemical theatre 4,000*l.* The new laboratory will accommodate at least 100 students; but at the pressure at which I work now, we might accommodate 200. As will be seen on the plan, the chemical theatre will accommodate from 300 to 400 students. It is 60 feet by 40, and is the largest theatre we have in the building. I have two large laboratories for students' work, each of which is 70 feet by 30; the one will accommodate 60 students working at qualitative analysis, and the other, of an equal size, will accommodate 40 working at quantitative analysis, at special investigations, and at original research.

7370. Those are two stages of one laboratory?—Yes. I divide the building into two. There are two long rooms, 30 feet high, lighted both at the side and at the top, which form the chief working laboratories. At the side we have a number of rooms for the various operations: assistants' rooms, library, balance rooms, organic analysis rooms, rooms for spectroscopic work, and electrolytic work; also rooms in the basement which are available for special purposes, as also furnace rooms and large store rooms for apparatus and materials. A class-room for smaller classes is also attached, and a room for a mineralogical cabinet. On the second floor, above this portion, is the laboratory and private rooms of the professor, and that is so arranged that he can see what is going on down below. The main building is to be of stone, but I have insisted upon having my building in brick, because I prefer rather to spend the money on the internal arrangements.

7371. (*Dr. Sharpey.*) Is there a first floor all over?—No, only a first floor over the end.

7372. (*Mr. Samuelson.*) Those two floors correspond, do they not, with the centre floor of the laboratory, which is very much higher?—Yes, the two being 30 feet high, and the furnace rooms, store rooms, and lavatories will be in the basement.

7373. (*Dr. Sharpey.*) For the qualitative students there will be 35 square feet per student, including passages, and for the quantitative students 52 square feet per student, including the passages?—Yes; but if we consider, in addition, the rooms for the separate operations, the total area for each student is 130 square feet. I might point out also that the chemical theatre, which is situated in the main building, and the room which is on the basement floor for the chemical museum, constitute the chemical department. With regard to the other science portions of the building, we have the Natural Philosophy Department, and the Engineering Department, and the Natural History Department. The Natural Philosophy Department occupies rooms at the back of the main building, consisting of workshops and laboratories on the basement floor, cabinets for the collections, laboratories, private rooms for the professors, and a large lecture room, capable of holding 300 students, on the ground floor.

7374. (*Professor Smith.*) Is there a laboratory for the students in the Physical Department?—Yes, the physical laboratories are arranged to be in the main building, an area of 3,200 square feet being appropriated to them. There is no separate building for the physical laboratory. The number of students attending the physical laboratory will for some time be necessarily small compared with those attending the chemical laboratory, but should it prove necessary, separate buildings especially devoted to the purposes of a physical laboratory will be built on the spare ground, of which we have plenty. The Engineering Department is at the other end of the building, and contains lecture rooms, workshops, museum, and large drawing office. The Natural History Department is the one which requires most enlargement. The Natural History class-rooms are placed at present on the first floor; the museum is in a room 26 by 20, and the Natural History class-room is 22 by 23. This is merely a temporary arrangement pending the erection of the museum, when

the lecture rooms and biological laboratories will be placed in a separate building, the one marked on the block plan. The remaining rooms in the building are devoted to the literature subjects and to general accommodation, as libraries, students' rooms, &c., covering an area of about 17,900 square feet.

7375. (*Professor Huxley.*) Then, I presume, you will have workshops and dissecting rooms for the students?—Yes, we intend to have them. Besides the portions of the building which I have described, the attic plan shows a large available space which has not yet been appropriated, and gives an idea of the amount of room which we shall have at our disposal.

7376. (*Chairman.*) Are those rooms in the attic a considerable height?—They are not so high as the other rooms, but they are good rooms. I think the large square room in the attic is 12 feet high. The rooms are 16 feet in the basement, and I think 18 feet on the ground floor. I should also state that it is in contemplation to attach to our College the Manchester Royal School of Medicine, and that suitable buildings will be added for the carrying out of the ordinary curriculum of a medical school.

7377. Can the cost of that be provided from any other fund?—That is the only difficulty we have. The cost for the medical school cannot be provided from any fund which we have at present, and we find it very difficult to get money for this purpose. The requirements which the medical gentlemen tell us are necessary are really very moderate; yet we have very great difficulty in raising the money, and the scheme is now hanging fire simply for that reason. (Since this evidence was given a donation of 10,000*l.* for this purpose has been made by Miss Brackenbury.—H. E. R.)

7378. Is there at present a medical school of any importance in Manchester?—There is a very considerable medical school, which I believe is one of the best provincial medical schools; at any rate there are about 100 students there, and we think that it will be greatly improved by being placed under a definite system of government. At present it is a private school, as many of the provincial medical schools are, and we know from experience that those schools which are placed in connexion with a large educational establishment stand higher and do better work than those mere medical schools, which are, in fact, technical schools in the most restricted sense of the word.

7379. Has it been brought into connexion with the College at present?—Steps have been taken. I have not with me, though we have printed, a series of statements showing the necessity or advisability of this absorption.

7380. I think that in the plans which you have shown us there is no provision for the proposed professor of mining and applied geology?—No rooms have as yet been specially devoted to this subject, but we have several which can be used for this purpose when the chair is founded.

7381. Would it require any considerable additional space?—I think there is plenty of space to be found for a considerable number of additional professors.

7382. Do you agree with Professor Greenwood, that the higher scientific instruction is not and never can be self-supporting?—Yes. I think that this has been proved by the experience of all countries for generations.

7383. (*Mr. Samuelson.*) Will you have the kindness to state the areas appropriated to each subject in the proposed building?—

The following are the areas of the different departments of the new building:—

#### I. Main Building.

(a.) Arts class rooms:	
Ground floor	= 1,800 square feet.
First floor	= 6,838       "
Total	= 8,638 square feet.



(b.) Professors' rooms, students' rooms, offices, &c. :

Basement	-	3,633 square feet.
Ground floor	-	2,177 "
First floor	-	3,480 "
Total	-	9,290 "

(c.) Engineering Department :

Basement	-	4,210 square feet.
Ground floor	-	3,847 "
Total	-	8,057 "

(d.) Natural Philosophy Department :

Basement	-	1,195 square feet.
Ground floor	-	3,165 "
Total	-	4,360 "

(e.) Natural History Department (temporary accommodation) :

First floor	-	total 2,668 square feet.
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(f.) Chemical Lecture Theatre and Museum :

Theatre	-	2,610 square feet.
Museum	-	802 "
Total	-	3,412 "

## II. Chemical Laboratories building at back.

Basement	-	6,487 square feet.
Ground floor	-	6,567 "
First floor	-	1,416 "
Total	-	14,470 "

7384. (*Chairman.*) I believe you have had opportunities of comparing the means of giving practical scientific instruction in this country with those existing on the continent?—I have some knowledge of the continental schools of science; a portion of my scientific education was carried on in one of them, at Heidelberg, and I know many of the others, and I am personally acquainted with many of the schools of science and the leading men in Germany and France. With your permission, I would make one or two observations on the Report on Foreign Science Schools alluded to by Mr. Greenwood, and then put it in. With regard, first, to the amount and kind of teaching power provided in the Science Department of the Universities and Schools of Germany, the first fact that strikes one is, that the number of teachers, both of the first and second grade, is considerably larger than in the English Universities and Colleges, even after account has been taken of the larger number of students, and this discrepancy is probably greatest in the science departments. Provision is thus made both for the effective instruction of students and for the zealous prosecution of original research. The Report then quotes a number of cases of different universities, with which I will not occupy the time of the Commission, but will rather pass on to the question of the working of the science departments on the continent compared with what we have in England. In the first place, the number of skilled assistants attached to each professorship, as a rule, is greater than we have in England. In Bonn and Berlin, one assistant is appointed to every 12 or 13 students; whilst in other laboratories a somewhat larger number of students is placed under each assistant. On the whole, the average ratio of students to assistants is 20 to 1, whereas I have only two assistants to 60 day students in my laboratory. In some cases the assistants are professors, and lecture on special subjects. The fees are much lower in Germany than with us, thus: the laboratory fee at Heidelberg for working six days per week for half the year, or for the semestre, as it is termed, is 4*l.* It is, however, to be borne in mind, that one great expense in working a laboratory is the cost of the apparatus and chemicals used by the students, and this is specially paid for in German Universities by the State. Thus, at Göttingen 140*l.* per annum represents the value of the chemicals

used by the students. In England, the greater part of this charge falls upon the professor. The scale of fees in the Chemical Department of Owens College is rather more than double that of Heidelberg. The cost of working the various laboratories in Germany may be of interest to the Commission. The cost of working the Berlin laboratory, exclusive of the salaries of the professors, is 600*l.* a year, but this is said to be insufficient; at Bonn it is 600*l.* a year, which is also said to be insufficient; at Göttingen, 540*l.*; at Leipzig, 600*l.*; at Heidelberg, 350*l.*; at the Berlin Polytechnic School, or the Gewerbe Akademie, 600*l.*; and in Zürich, at the Polytechnic School, 500*l.*

7385. Are all those laboratories on a large scale?—Those are all laboratories on a large scale, but many of them do not accommodate so many students as my new one will do. I have here a Report on the German Laboratories of Bonn and Berlin, which is written by Dr. Hofmann, and was printed by the Science and Art Department (*handing in the same*), and this is a similar French Report, written by Monsieur Wurtz of Paris (*handing in the same*), which contains a very full account, not only of the chemical laboratories, but also the physical and biological laboratories as existing in the various German Universities and Polytechnic Schools. To give an idea of the amount which the German governments spend on those buildings, I may state that the cost of the Berlin laboratory was 47,715*l.*, 28,365*l.* being for the building, and 3,750*l.* for the internal fittings, and the remainder for the land. It is interesting to remark that this is a cost of 45*l.* per head on each student per annum of the 60 students which that building can accommodate. I think we are doing the thing, I mean as far as buildings are concerned, much more cheaply, and, I hope, as efficiently.

7386. Are you of opinion that the provision in the German Universities is at all above what is really required in the way both of buildings and assistants?—I think that more money has been spent upon several of those laboratories than was necessary. I do not mean that the accommodation which they give is more than is wanted, because they are now, many of them, full, but I think that the money has in some cases been somewhat lavishly spent. With regard to the assistants, and to the grants for working expenses and for the purchase of apparatus, I believe that there is not at all too much spent.

7387. You would like to see as much assistance provided in the English schools?—I should.

7388. (*Sir J. P. Kay-Shuttleworth.*) You would almost think that essential to good teaching, would you not?—Yes, almost essential to good teaching with a similar number of students.

7389. (*Chairman.*) You would suggest an assistant for about every 20 chemical students?—Yes. I now beg leave to hand in the following Report:—

## OWENS COLLEGE EXTENSION.—REPORT TO EXTENSION COMMITTEE.

In accordance with the instructions of the Committee, we visited, in the course of July, the following Universities and High Schools of Science:—Bonn, Göttingen, Hanover, Berlin, Leipzig, Freiberg, Heidelberg, Karlsruhe, Munich, and Zürich. Buildings and museums were everywhere thrown open to us with the utmost readiness, and our inquiries were freely answered. We prosecuted the task confided to us in as great detail as was allowed by the necessity of completing our circuit by the end of July; and we beg leave to offer to the Committee the following Report of the results of our mission, premising (1), that our inquiry was chiefly, but not exclusively, directed to the Science Departments of the Universities and Schools visited; and (2) that in this report we have thought it sufficient to give a full account of one or two only of these schools—such as seemed to us the most typical; much of the matter collected by us, both as to schemes of study and as to buildings, being reserved for the use of the Committee, as they proceed with the details of their task.

We propose to arrange our report under the following heads:—

- I. The amount and kind of teaching power provided in the Science Department of the Universities and Schools inspected by us.

H. E. Roscoe.  
Esq., B.A.,  
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31 March 1871.



H. E. Roscoe,  
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31 March 1871.

- II. The provision made, *a.* for the payment of the professors; *b.* for the payment of the assistants; *c.* for the maintenance and augmentation of apparatus and collections.
  - III. Plans of buildings, &c., and their cost.
  - IV. Rules of studentship in respect of age, preliminary attainments, and length of study.
  - V. Relations existing between Universities proper, and Polytechnic Institutions; and again, between these, on the one hand, and schools, whether gymnasia or real-schulen, on the other. The attitude of the scientific towards the old classical culture.
  - VI. Relations existing between State Governments and Academical Bodies.
  - VII. Seminaria, &c.
  - VIII. Conclusions.
- I. *The amount and kind of teaching power provided in the Science Department of Universities and Schools visited.*

The first fact which impresses the English observer of German Universities under this head is this—that the number of teachers, both of the first and second grade, is considerably greater than in English Universities and Colleges, even after account has been taken of the larger number of students; and this discrepancy is, perhaps, greatest in the Science Departments. Provision is thus made both for the effective instruction of students, and for the zealous prosecution of original research. It is in this fixed union of teaching with independent research that Prof. von Sybel, the Rector of the University of Bonn, in his eloquent lecture “on German and Foreign Universities,” finds the special excellence of the German Universities to consist. The combination is cherished, not only with a view to the advancement of science, but because by this union in one body of students, teachers, and discoverers, a school is made, students are drawn from a wider area as to an acknowledged centre of intellectual action, and an *esprit de corps* is created, which reacts with incredible effect on the energies of teachers and learners alike.

#### BONN.

We begin with Bonn. In the University of Bonn there are two professors of chemistry, Kekulé and Landolt, who are respectively ober-director and director of the newly-erected chemical institute; and under these are five skilled assistants—one for organic chemistry, one for qualitative and one for quantitative analysis, one for the lecture-room, and one a sort of supernumerary. Again, Professor Bischof is director of the chemical laboratory and technological cabinet. There are, besides, directors of the pharmaceutical laboratory and apparatus, and probably other officers in this department.

The Department of Physics does not appear to be now in a thriving state at Bonn, owing, probably, to the recent death of Prof. Plücker. The directorate of the department, with its cabinets, is vacant.

In the Natural History Department we find two professors, who are also Directors of the Natural History Museum. The museum also possesses a Curator of the Palæontological Collection, who, at the same time, is an authorised lecturer on his subjects. Attached to the Botanical Garden and Institute are a professor, an inspector, and an assistant. No account is here taken of the anatomical and physiological professors, who are included in the faculty of medicine.

Of Astronomy there is one professor, Dr. Argelander, who is also Director of the Observatory; he has one skilled assistant.

In the Department of Chemistry we are able to make a comparison with the provision existing in Owens College, in a ratio with the number of students taught. There are about 90 students in Professor Kekulé's largest class, and in the three laboratories is room for 60 workers, though these 60 places are not all filled. At Owens College, last session, there were 76 students in the largest class, and 44 workers in the laboratory; and our staff consists of one professor and one assistant.

The total number of students at Bonn in the Philosophical Faculty (Faculty of Arts), for the summer half year of 1868, was 275; the number of ordinary professors was 27; of extraordinary professors, 11; and of authorised private teachers (lecturers), 19.

#### GÖTTINGEN.

In Göttingen chemistry is (against the usage in Germany) attached to the medical faculty; there are, however, three divisions—the general, the physiological, and the agricultural. In the first, we found Professor Wöhler, with four skilled assistants; two of these being also professors.

In the physiological division is another professor, with one assistant; and in the agricultural division is one professor and one assistant. There are, further, four laboratory servants.

Prof. Wöhler delivers the principal course of lectures on systematic chemistry. His assistants lecture on special branches. The whole staff directs the laboratory; and over and above these are the two professors of physiological and agricultural chemistry, who conduct their own laboratories.

In physics, Professor Weber and his assistants, Professors Listing and Kohlrausch, conduct an excellent physical laboratory, and lecture on the several branches of physics—Systematic Physics, Optics, Electricity, &c., Light and Heat, Meteorology. Prof. Ulrich treats of hydrostatics and hydraulics.

In Natural History, Professor Keferstein lectures on comparative anatomy, and performs zootomical demonstrations in the Zoological Museum during eight hours weekly to the students; for four hours weekly the museum is open to the public, when the same professor is present to conduct demonstrations. Two professors lecture on botany (each six hours weekly), and combine with their lectures excursions and demonstrations in the botanical garden; there is also a third assistant professor. Professors Sartorius von Waltershausen and von Seebach lecture each four or five hours weekly on mineralogy and geology, and conduct practical demonstrations in the museums.

Professor Klinkerfues lectures on astronomy, theoretical and practical.

We have given this minute analysis of the provision made at Göttingen for the study of the sciences of observation and experiment, as the routine of any one of the leading Universities serves to illustrate the method adopted in Germany. Göttingen, it will be remembered, is not one of the more recently-founded Universities, nor is it in any special degree subject to the influences which have so remarkably fostered the growth of the branch of education under consideration.

#### BERLIN.

Of Berlin University it will be enough to say that in chemistry four professors and five other lecturers give 20 distinct courses—theoretical and practical—among which, in addition to several distinct courses on systematic chemistry, are included such subjects as the history of chemistry, the chemical foundations of geology, metallurgy, and pharmacy.

Under the head of physics, the following distinct courses were given in the summer half year of 1868:—

Experimental physics	-	-	4 hours weekly.
Technology	-	-	5 „ „
Acoustics	-	-	4 „ „
Capillary theory	-	-	2 „ „
Theory of light and optical instruments	-	-	2 „ „
Physiological optics	-	-	4 „ „
Mechanical theory of heat	-	-	1 „ „
Hydrography	-	-	1 „ „
Physical geography, theoretical and practical	-	-	2 „ „
Instruction in the method of making geographical and physical observations	-	-	3 „ „

These 10 courses are given by seven professors; and a physical laboratory is conducted by Professor Magnus.

In Natural History 10 professors and lecturers gave 21 courses, theoretical and practical.

It will complete this analysis of the courses given in the University of Berlin in the summer semester of 1867-8, if we add that—

In classics and the allied subjects 13 professors and lecturers gave 23 courses; and on other ancient and on modern languages 18 professors and lecturers gave 40 courses.

In mathematics six professors and lecturers gave 13 courses.

In what we should term mental and moral philosophy, including pædagogy, 11 professors and lecturers gave 19 courses.

In the economic and agricultural sciences seven professors and lecturers gave 12 courses.

In history and geography nine professors and lecturers gave 13 courses.

In belles lettres and the fine arts seven professors and lecturers gave 10 courses.

All the courses enumerated above belong to the faculty of arts (philosophische facultät), and are exclusive, of course, of the three other faculties of theology, law, and medicine.



It is unnecessary to say that we do not set forth this list of teachers and lecturers as a pattern for us to follow in Owens College, or in English Universities generally. We only desire to point out and emphatically to press the importance of the principle that the existence (in due proportions) of a plurality of teachers is an indispensable prerequisite both for breadth and depth of instruction. Where only one teacher is charged with one leading branch of study, it is barely within his power to provide the systematic teaching necessary for pass-men; whereas, if, as in German Universities, several teachers lecture concurrently on subdivisions of a subject, the more advanced students have the opportunity of studying more thoroughly some one section of their subject. The teachers are also induced, by the opportunity of lecturing on special subjects, to engage in profounder investigations; and thus that other aim of University institutions—the advancement of science and the promotion of a learned class—is furthered. This is a consideration, however, at least so far as England is concerned, for a remote future; it is sufficient for us to insist on the necessity of this plurality of teachers in order to really effective teaching.

The Berlin Gewerbe-Akademie, which corresponds to the polytechnic schools of Zurich and Carlsruhe, is an institution of the first magnitude. There are 520 students between the ages of 18 and 25, and a very complete staff of professors. It is divided into three departments—(1) of mechanics, (2) of chemistry and metallurgy, (3) of ship-building; and it is proposed to add a fourth, to be called the philosophical department, to embrace subjects appertaining to general culture, including even the "beaux arts." The State allots 7,800*l.* yearly to the support of the academy, and, in addition to this, large sums have been spent on the collections of models and casts, and on the very complete library.

#### LEIPZIG.

In Leipzig University the new laboratory is just approaching completion, and it appeared to us to offer one of the best models, as to plan, style, and cost. Provision is being made for 160 workers—60 of them beginners, and 40 more advanced students. Prof. Kolbe, the Director, will be furnished with three skilled assistants—two for the laboratory and one for the lecture-room—but Dr. Kolbe believes that four will, in fact, be necessary. In addition three servants will be provided.

#### HEIDELBERG.

In Heidelberg, as in Berlin, and even in a more perfect measure, large provision is made for the study of physical science. The Physical Laboratory conducted by Prof. Kirchhoff is very successful. Once weekly, Prof. Kirchhoff lectures, with experiments, on a given subject; in the following week each student in the laboratory goes through the experiments for himself; and in this consists the essence of the course. Students can also prosecute independent research for several hours in the week.

The Chemical School of Heidelberg has always been a celebrated one, and since the appointment of Bunsen to the University, its renown has greatly increased. In no other European laboratory, with the single exception of that of Liebig, at Giessen, have so many promising scientific chemists been trained, and this has been wholly due to the untiring interest shown in each student by the illustrious Professor, who, devoted heart and soul to his science, imparts to his students a portion of that interest in, and zeal for, original investigation, which are the real marks of a scientific spirit. Many of the chemical students at Heidelberg come, as with us, to study the science for the sake of its subsequent applications to manufactures, medicine, or pharmacy—for all the German druggists and pharmaceutical chemists are wisely compelled to attend a regular University course; but many, probably a large fraction of the number, study the science for its own sake, most of these students intending to qualify themselves for the higher posts of scientific instruction in various countries. Amongst the companions of those who studied at Heidelberg with one of the reporters were men who are now making rising reputations in most of the German Universities, or in the various scientific institutions of France, Russia, Portugal, Great Britain, and America.

The Physiological Laboratory, conducted by the celebrated philosopher, Helmholtz, is a novel and important feature in the science department in Heidelberg. A handsome and spacious building has recently been erected for the use of the professors of physics and physiology. This embraces lecture-rooms, laboratories, rooms for apparatus and instruments, and for conducting special scientific investigations, besides dwelling-houses for the professors and their families.

We were conducted over the admirably-kept zoological collection by the chief director, Prof. Pagenstecher. The yearly sum at his disposal for the maintenance and augmentation of the collection is 1,400 gulden; in round numbers, 120*l.* Of this sum he devotes 50*l.* to the acquisition of new specimens; 35*l.* to the cost of preparations; 25*l.* to glass and other materials; and 10*l.* to heating, &c. Many of the more costly specimens have not been purchased, however, but formed the nucleus of the museum. Still, by being always on the look-out, he often procures really valuable things for small sums. He told us with great triumph of his most recent acquisitions—a huge bison, from the Zoological Garden of Cologne, for 6*l.*, and a *Baleenoptera rostrata* for 16*l.*

The cases (which are fitted with iron, not wood, for the larger specimens) alone have cost more than 1,000*l.*; this sum is not included in the annual estimate.

Prof. Pagenstecher insisted with great animation on the necessity of sufficient funds for maintaining and enlarging the collections. He told us he was always waging a fierce battle "*einen grossen Kampf*" with his preparations, though he managed to keep them under with the assistance of four or five young men, who help him to dissect and prepare in his laboratory.

In the winter half year Prof. Pagenstecher gives courses on special zoology, comparative anatomy, and comparative physiology, with microscopic demonstrations; in the summer half year he gives general zoology and palæontology.

The cases in the museum are freely open to the students, and a small catalogue is placed in each. All the year round a sort of zoological laboratory goes on for zootomical practice.

Dr. Pagenstecher is professor of the subjects enumerated and director of the museum. On hearing of our present arrangement for teaching Natural History in Owens College, he expressed his surprise at the inadequacy of the provision. In his judgment it is not possible to do with fewer than three professors at least, viz. :—

- Of Geology and Palæontology.
- „ Zoology and Human Physiology.
- „ Botany.

#### CARLSRUHE.

The science schools in Bonn, Göttingen, Berlin, Leipzig, and Heidelberg are integral parts of those Universities; in form, indeed, they do not even constitute a distinct faculty, being annexed to the Faculty of Arts. In Carlsruhe, however, exists an example of that important institution of modern Germany—the Polytechnicum. The Polytechnicum may be defined as an institution for teaching, on the largest scale, all the branches of the sciences of experiment and observation, and not only in their principles, but in their application to the several industrial arts—these applications being not treated as illustrations of science merely, but rather regarded as the main subjects for instruction, for the sake of which systematic lectures were given on theoretic science.

The Polytechnic School at Carlsruhe, with that at Zürich, seemed to us to be very ably and successfully conducted, and to contrast favourably with some other institutions of the same kind, in the more highly scientific character of its teaching, both experimental and theoretic.

It is worth while briefly to describe the constitution of this important institution, with its 600 students.

In the original programme the school was declared to consist of *one* general and *seven* special departments. The general department, called the mathematical, furnished instruction in mathematics, in natural science, and in modern languages and literature; and was viewed as preparatory to the special schools, and also as adapted for those who proposed to become teachers of mathematics and natural science. The seven special schools were of (1) Civil Engineering; (2) Mechanical Engineering; (3) Architecture; (4) Forestry; (5) Manufacturing Chemistry; (6) Commercial Studies; (7) Civil Service (Postschule). This constitution is in the latest programme so far modified that (1) the general department is no longer treated in form as introductory to the rest, though it still appears to be so virtually; and (2) the last two of the special departments enumerated above are omitted, while an agricultural department is added. The schools are, therefore, now seven, viz. :—

1. The School of Mathematics.
2. „ „ of Civil Engineering.
3. „ „ of Mechanical Engineering.
4. „ „ of Architecture.
5. „ „ of Chemistry.
6. „ „ of Forestry.
7. „ „ of Agriculture.

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The teaching staff consists of the 24 professors and 16 assistant lecturers and laboratory assistants. The appliances comprise five laboratories (viz.: Chemical, Physical, Mineralogical, and for Forestry and Agriculture), a library, and 12 different cabinets or collections. The Department of Natural Philosophy appeared to us to be very ably conducted: as many as 120 students attend the lectures of Prof. Wiedemann, in the large theatre of the department; and the cabinets (which are the private property of the Grand Duke) are large and well arranged. In the physical laboratory were 14 students, who go through the course in groups of four; most of these become teachers of the subjects in Real-Schulen; some get important posts in large mechanical workshops.

#### MUNICH.

In Munich, as in Berlin, there are a University and a Polytechnic School side by side.

The newly-founded polytechnicum in Munich is to absorb the schools hitherto existing in Augsburg, Nuremberg, and Würzburg. The buildings were not completed at the date of our visit.

Dr. Jolly, professor of experimental physics in the University, in addition to his lectures, conducts a very important department called the Mathematico-Physical Seminary. There are at present about 10 or 12 in this department, which, with the physical laboratory, is open to all who propose to become teachers of physics in the Real-Schulen. Professor Jolly's method is much the same as that of Prof. Kirchhoff. He goes through each set of experiments once, and after that the students endeavour to perform them. When they fail to succeed they consult the professor or his assistant. At the end of the semester there is a practical examination.

#### ZÜRICH.

In Zürich, also, there are both a University and a Polytechnic School; and although the University is a cantonal and the school a federal institution, they are so far allied, that they share one building, and many students of the University are, at the same time, pupils in the school. The total cost to the State for the maintenance of the polytechnic school is 12,000*l.* per annum. The professors of the two institutions, moreover, work to a certain degree in concert. For instance, Dr. Bolley is professor of chemistry in the school, and Dr. Städler, professor of the same subject in the University. They have each a laboratory; but Prof. Städler's is an analytical, and Prof. Bolley's a technical laboratory. There are 42 students working in the former, and 50 in the latter.

There is less freedom allowed to pupils of the school as to the class to be attended. Definite courses are laid down; but, as at Owens College, relaxations are freely granted.

The most important department of the polytechnic school is that of mechanics and engineering; there are also departments for forestry and agriculture, and an important department for teachers—a sort of technological seminary.

The professor of technical or applied chemistry, Dr. Bolley, lectures about three or four times weekly throughout the session. He makes four or five subdivisions: as the chemistry of colour; of heating and lighting; of materials; of nourishment; of agriculture. Before entering this class the student is required to have attended a theoretical course and an elementary experimental course.

Dr. Zeuner, the professor of engineering, gives about 50 or 60 lectures yearly on the mechanical theory of heat; and he lectures six times a week for two semesters, on the theory of machines. The character of his courses is very high and rigorous; he insists on a knowledge of the differential calculus as a condition of entering his classes. He proceeded to remark on the generally inadequate mathematical preparation of English students of engineering, and mentioned his conviction that Professor Rankine, for whose works he expressed an unbounded admiration, must find the sphere of his efficiency as a teacher seriously limited by reason of the want of due preparation on the part of his students.

The following extracts from the prospectus of the lectures in the engineering department of the Zürich school show how much more complete is the scheme of instruction there than has at present been found possible in England:—

#### B.—Department of Civil Engineering.

(Duration of course, 3½ years.)

1st year.—Differential and integral calculus. Descriptive geometry. Principles of construction. Practice in construction. Drawing. Experimental physics. Experimental chemistry.

2d year.—Differential equations. Technical mechanics. Geometry of three dimensions. Perspective. Technical geology. Topography. Drawing. Descriptive mechanical construction. Surveying.

3d year.—Theoretical mechanical construction. Astronomy. Geodesy. Construction of iron bridges, railways, and iron roofs. Drawing.

In addition to these courses there are similarly extensive programmes for (A) the Department of Architecture, and (C) the Department of Mechanical Engineering. The number of regular students in the year 1867 was in these subjects: (A) Department of Architecture, 33; (B) Department of Civil Engineering, 103; (C) Department of Mechanical Engineering, 87.

*Freiberg Mining Academy, Saxony.*—This school, of world-wide reputation, offers many advantages over our Royal School of Mines in Jermyn Street, inasmuch as it is situated in the centre of a mining district, and combines complete courses of lectures on all the branches of science allied to mining, with practical instruction, not only in the working of mines (chiefly lead, copper, and silver), but also in the metallurgical processes, carried out on the large scale, employed in the extraction of the metals from their ores. This school has been famous ever since its foundation in 1766. Amongst the names of its professors are found the most illustrious geologists, mineralogists, miners, and metallurgists of the time. The number of students at the school this last summer was 92, and of these nearly half were young men from the United States, who come over in large numbers to study mining; indeed almost every nation is here represented. Foreigners pay fees amounting to 30*l.* per annum, but the fees for Saxon students are almost nominal. We were told that there is at present no demand whatever for miners in Saxony, and that in consequence the number of Saxon students has greatly diminished. The following list of lectures and practical courses delivered at Freiberg in the year 1865–6 gives an idea of the character and extent of the tuition:—

Subjects.	No. of Lectures per Week.
Mathematics, 1st division - - -	4
Descriptive Geometry - - -	4
Elementary Mechanics - - -	4
Mathematics, 2d division: and Mechanics -	4
Elementary Mechanics applied to mines -	3
Construction of machines used in mining,	
1st course - - - - -	2
2d course - - - - -	4
Drawing - - - - -	14
Physics - - - - -	4
Theoretical Chemistry - - - - -	4
Practical Chemistry - - - - -	4
Analytical Chemistry - - - - -	4
General Underground Surveying - - -	2
Practical Underground Surveying - - -	2
Practice in such surveying - - - (daily)	9
General Metallurgy - - - - -	4
Metallurgy of iron - - - - -	2
Assaying in the dry way - - - - -	1
Mineralogy and Repetition Lecture - -	4
Practical Mineralogy - - - - -	1
Theoretical Crystallography - - - - -	2
Geognosy and Repetition - - - - -	5
Palæontology - - - - -	1
Geology of Ores - - - - -	2
Civil Engineering - - - - -	3
Mining Engineering, 1st division and repetition - - - - -	5
Mining Engineering, 2d division and repetition - - - - -	5
Practical Assaying - - - - -	15
Practical Assaying in the wet way - - -	2
Blowpipe Assaying - - - - -	6
Mining Law - - - - -	4
Book-keeping - - - - -	2
French - - - - -	4

One day per week is left free from lectures, to enable the pupils to visit the mines and smelting works. All those who wish to pass the Government examination, and thus to qualify themselves for a post in the Saxon mines (which are all worked and owned by Government), must, before they enter the mining school, undergo a preliminary examination in general knowledge, and then devote five months to practical mining. A similar preliminary course in smelting is necessary before the Saxon student can be admitted to the lectures of the academy; these two practical courses, whilst obligatory on all regular or Government students, are open to all who wish to take advantage of them. After having



gone through the academy, the Government student has to pass an examination arranged, according to the special part of the subject to which he devotes himself, (1) for miners; (2) for mining surveyors; (3) for machinists; (4) for smelters.

We were conducted by the veteran mineralogist, Breithaupt, to see the unrivalled collection of minerals which he has brought together during his 50 years of successful labour at the academy. The whole of this, in many respects, the finest collection in the world has been made with the small annual grant of 45*l.*; but of course the mineralogical richness of the locality has greatly assisted the collector.

Connected, in a certain extent, with the Freiberg Academy is the recently-founded Free Mining School of Zwickau, established by the State chiefly for the education of the workmen engaged in the coal mines of Saxony. In this school the miners spend two days a week, working the rest of the time at their trade. The subjects taught are mathematics, German language, mineralogy and geology, and practical mining. Some of the most distinguished pupils of this school subsequently obtain free admission to the Freiberg Academy. The only institution analogous to this in our country appears to be the Bristol School for miners; it is high time that steps were taken to do something for the education of the higher class of pitmen in our district, amongst whom a deplorable state of ignorance exists.

## II. The Provision made for the payment of Professors and Assistants, and for the maintenance and augmentation of Apparatus and Collections.

1. *Professors.*—The Professors ordinarii, at the German Universities and Polytechnic Schools, are servants of the State, and, as such, all receive salaries from the Government, varying in amount from 50*l.* to 400*l.* per annum, according to the importance of the chair and the standing of the professor. In addition to this fixed stipend, a large portion, or in many cases the whole, of the fees falls to the professor, and generally dwelling-houses are attached to the establishment for the accommodation of the professor and staff. In the case of several of the leading professorships the houses are spacious and handsome, and valued at least at 100*l.* per annum.

2. *Skilled Assistants.*—Attached to every professorship of chemistry are several assistantships. The assistants are chosen by the professor from the most promising or best qualified students; they are also State servants, and receive salaries from Government amounting to from 40*l.* to 60*l.* per annum, with the addition of residence, with fire, &c. The duties of these assistants are (1) to attend to the preparation for illustrating the experimental lectures of the professor; (2) to assist in the practical teaching in the laboratory. For the first of these purposes the services of one assistant is required; for the second a number of assistants are required, in proportion to the number of students working. In Bonn and Berlin one assistant is appointed for every 12 or 13 students, whilst in other laboratories a larger number of students are placed under each assistant. On the whole, we find that the average ratio of students to assistants is 20 to 1. In some cases (as at Göttingen) the assistants are professors (extraordinarii) in the University, and lecture on special-subjects, as well as take a certain number of the beginners in the laboratory altogether off the hands of the professor.

3. *Fees.*—The fees both for lectures and laboratory practice are much lower than with us. This is, of course, explained by the fact that all the science schools are Government institutions. Thus, at Heidelberg the fee for the lectures on chemistry (five hours weekly, for from four to five months) is 1*l.* 14*s.* per "semester," whilst the laboratory fee is 4*l.* for working six days per week during the same period. It is, however, to be borne in mind that one great expense in working a laboratory is the cost of apparatus and chemicals used by the students; this is specially paid for in the German Universities by the State. Thus, at Göttingen, 140*l.* per annum represents the materials used by students. In England the greater part of this charge falls upon the professor. The scale of fees in the Chemical Department in Owens College is rather more than double this amount.

4. *Working Expenses.*—Through the kindness of the professors of chemistry at the several institutions which we visited, we are able to give the following statement of the expenses of working the Chemical Department, including all charges but the salaries of the professors:—

26060.

## Accommodation for Students.

	Laboratory.	Lectures.	Assistants.	Yearly Expenses.
1. Berlin University	60	200	5	£600 (insufficient)
2. Bonn	60	200	5	£600 (ditto)
3. Göttingen	80	150	4	£540
4. Leipzig	100	135	3	£600
5. Heidelberg	50	110	2	£350
6. Berlin Polytechnic School (two chairs).	40	—	4	£900
7. Karlsruhe Polytechnic School	—	—	—	—
8. Zürich Polytechnic School (two chairs).	60	66	8	£500

H. E. Roscoe,  
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31 March 1871.

## III. Plans of Buildings, and their Cost.

We have obtained the following plans:—

1. General Ground Plan of Zürich Polytechnicum.
2. Leipzig Chemical Laboratory (pamphlet on).
3. Stuttgart Chemical Laboratory; ground plan.
4. Göttingen Chemical Laboratory
5. Karlsruhe Chemical Laboratory; ground plan and pamphlet.
6. Heidelberg Chemical Laboratory; pamphlet.
7. Bonn and Berlin; Hofmann's pamphlet.
8. Göttingen University Buildings (photograph of ground plan).
9. Karlsruhe; general plan, in Koristka's book.
10. Zürich Chemical Laboratory, in Koristka's book.
11. Munich Polytechnicum; photographs of the working plans.

## Cost of Buildings.

1. The spacious and stately buildings at Karlsruhe were erected for not more than 30,000*l.*
2. The buildings now erecting at Munich, in a very costly style of architecture, will cover five acres, and the estimate for erection and fittings is 125,000*l.*
3. The cost of the magnificent building at Zürich, shared between the University and the Polytechnic School, was 160,000*l.* (including the land?); of this total the laboratories cost 20,000*l.*
4. The cost of the new buildings for physical science in Heidelberg, including museums, lecture-rooms, and residences for two professors, with fittings, but exclusive of the land, was 15,000*l.*
5. The new University building at Göttingen cost, with fittings, 12,000*l.*, exclusive of land.

## The Cost of Building and Furnishing the Laboratories.

1. *Berlin.*—Total outlay, 47,715*l.* (including land, compensation, &c.); building, 28,365*l.*; internal fittings, 3,750*l.*  
(The annual interest on this enormous outlay amounts to 45*l.* per head of each of the 60 students accommodated in the laboratory.)  
Number of available places in laboratory, 60; accommodation for lecture students, 200.
2. *Bonn.*—Contract for building, 18,450*l.* (without land); fittings and internal arrangements, 5,250*l.*  
Number of laboratory students, 60; lecture accommodation, 200.
3. *Leipzig.*—Contract (or estimate?) for building, 12,000*l.*; internal arrangements?  
Number of practicans, 100; lecture accommodation for 135.
4. *Heidelberg.*—Contract for building, 5,000*l.*; land, 1,500*l.*; internal arrangements?  
Number of practicans, 50; lecture accommodation, 110.
5. *Zürich.*—Building and fitting laboratories, 20,000*l.*  
It must be remembered that the cost of labour and material is very much (say one half) lower in Germany than with us.

## General Expenses of Education at Polytechnic Schools.

1. *Carlsruhe.*—66 *fl.* per session of nine months - £5 10 0 } for lectures alone.  
Entrance fee - 0 10 0  
Chemical laboratory fee to students - 3 15 0  
Chemical laboratory fee to non-students - 5 0 0  
Physical laboratory fee to half year's course - 0 15 0
2. *Zürich.*—109 *frs.*, or about 4*l.* 4*s.* for the session of nine months.

3 S



H. F. Roscoe,  
Esq., B.A.,  
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31 March 1871.

#### IV. Rules of Studentship, in respect of Age, Preliminary Attainments, and Length of Study.

The ordinary age for entrance at the German Universities is 18, the age at which the gymnasium is in due course left. The time of study in the University extends over three years (six semesters); not a few students remain a fourth year, and such are the demands of the rapidly extending range of studies, that some of the most enlightened among German academical authorities earnestly press the necessity of measures for enabling at least a large portion of the better students to spend a fifth year at the University.

In ordinary cases, the qualification for admission to the University is the possession of a testimonial that the bearer has satisfactorily passed through the studies of some gymnasium or public grammar school. This testimonial is called the "leaving certificate," or certificate of ripeness or maturity, and is given by an examining board, armed with public authority, after an examination held chiefly by the director, or, as we should say, the head master of the school. The head master, however, does not pronounce by means of the examination alone, but by means of this coupled with his knowledge of the school-career. The president of the board has a veto on the decision of the head master. Young men who have not studied in a gymnasium may undergo a corresponding examination. In practice, however, the majority of University students appear to pass through the gymnasium to the University.

Such is the qualification for regular studentship. A considerable number of persons, however, not thus qualified, can attend single courses of lectures, but this attendance does not count towards the three years which qualify for the University degree, and for admission to professions and the public service. Changes are said to be impending in this respect; for the German Universities, like our own, are just now in a stage of transition. For State posts (the Civil Service) the old rule still applies, that no one who has not come to the University with the strict testimonial that he has satisfactorily gone through the previous gymnasium course can expect to enter the service of the Government.

The age for entrance into the polytechnic schools is one year younger than that for the universities, viz., 17; the duration of study is the same, three years. Here, too, evidence of fitness is rigorously exacted of those who propose to enter as *regular students*, in the shape of an adequate school certificate, either from a Gymnasium, a Real-Gymnasium, or a Real-Schule—or, in default of that, an entrance examination must be passed. A much higher mathematical preparation is demanded, at least up to, and in some schools, including, the differential calculus. Persons of all ages, however, and not possessing such qualification, are admitted freely and without examination, as *occasional students* in the several departments. Many of these occasional students were, we were informed, poorly prepared; but it was considered that the gain to such auditors, and to society through them, was very great; and that, whatever tendency might arise from the practice towards the lowering of the standard of instruction, could be guarded against by rigidly keeping up the standard of admission for regular students.

To many of the Polytechnica is attached a preliminary school, in which those who are not ripe for the full studies of the Polytechnicum can supply their deficiencies. The age for entrance to this *Vorschule* is *sixteen*.

The essential feature of the regulations which have been briefly described is this: that, ordinarily, the University or Polytechnicum, and the Liberal Professions (including the service of Government) stand in a close and recognised relation to each other. The profession cannot be entered without evidence that the three years' University course has been satisfactorily gone through; nor is it allowed to matriculate at the University without the "leaving certificate," gained in the majority of cases after from six to nine years' study in the gymnasium, or a corresponding certificate of adequate fitness tested by rigorous examination. This system, of course, presupposes such an organisation of schools and colleges, and such reciprocal relations between them, as do not—and, probably, could not—exist in England.

#### V. Relations existing between the Universities proper and the Polytechnic Institutions; and again between these, on the one hand, and schools, whether "Gymnasias" or "Real-Schulen," on the other.—The attitude of the scientific towards the old classical culture.

We have had occasion to refer to four kinds of institutions—Universities; Polytechnic Institutions (a sort of

Science Universities); Gymnasias (*Anglice*: Grammar Schools); and Real Gymnasias (High Schools of Science); these last being newly-established schools, designed to prepare boys specially for the Polytechnica.

It appeared to us that very great evils must result from this tendency to multiply institutions—a tendency springing, probably, from the difficulty of modifying old institutions to meet new wants. In the first place, there is room to fear that a due supply of thoroughly good teachers, especially in science, at least in the higher positions, cannot be secured for institutions perpetually growing in number; while, on the other hand, a great waste of power is caused, where such institutions exist side by side, as many of the professorships, being common to universities and polytechnic schools, are thus twice represented. It was alleged that this evil is already showing itself in Germany; and it is probable that in England the danger would be greater still.

Again, serious harm must come from the tendency which this separation of the Polytechnic School from the University has to foster the narrow one-sidedness already so strong in the extreme partisans of the one and the other group of studies. The universities would suffer by the weakening in them of those branches of pure and applied science which have always been and must continue to be studied there. The polytechnic schools would suffer (and already do suffer) from the tendency, thus encouraged, to neglect the educational aspects of science in its practical applications. How great the gain has been to all branches of the liberal arts and sciences from their alliance in universities, the history of universities from their first foundation abundantly shows; and it is difficult to see any sufficient reason why the applied sciences in their professional aspect should not have their proper place in the organisation of our universities exactly as theology, law, and medicine have long had their place—to the great advantage both of these studies themselves and of the non-professional studies with which they have been brought into contact.

Prof. Magnus, the eminent professor of natural philosophy at Berlin, already detects signs that the new-born zeal for teaching science in its application to the practical arts is encroaching on the domain of science proper, and that it will thus deteriorate science without, at the same time, advancing industry. The true work of institutions, founded with the special aim of fostering the industrial arts, should be to insist on teaching *principles* systematically, and not in their isolated applications. To treat of the applications of science is, of course, necessary, even for the sake of science itself; and, under certain circumstances, some of these applications may wisely be more dwelt on than others; but this is quite a different thing from pretending to teach as *science* detached fragments of science in their application to this or that art.

Many of the most experienced and sagacious of our advisers, while themselves pointing out this danger, saw great difficulties in the way of the one obvious remedy for it—the absorption, namely, in many cases, at all events, of the Polytechnicum in the University. The chief of these difficulties arises out of the ancient tradition of the German Universities—the much boasted *Lern- und Lehr-Freiheit*—by which the amplest license is left to professors, as to what they shall teach, and to students, as to what they shall learn: whereas, in the Polytechnica, it is found necessary to lay down a much more definite course of study, and to exact attendance upon it.

This is, no doubt, a serious obstacle in the way of the proposed amalgamation in Germany, but in England, and especially in a college of recent foundation, the difficulty would not arise at all. Apart from questions of tradition and historical routine, there can be no reason why students of applied science, led to the study by their probable destination to manufacturing industry, should not study systematic science in the same class-rooms with other students of the same subject; and if such students require minute practical and experimental instruction, there is no reason why they should not obtain this in physical and mechanical, as they do already in chemical laboratories. In such a technical department the future teachers of science and leaders of manufacturing industry would be trained in the application of science to the most important branches of art and manufacture—in so far, that is, as these are fit subjects for academical treatment; in so far as they are not, they are better left to the workshop.

*Schools.*—Although we were not directly instructed to inquire into questions connected with secondary schools, we found it impossible wholly to pass them by. We were informed that the relations between schools and the higher institutions (whether universities or polytechnica) were



being warmly debated in Germany, and that great changes were probably impending.

At present, as has been said, no one can be regularly inscribed as a University student without the "leaving certificate" from a Gymnasium, or a certificate showing a corresponding degree of preparation; and the same is true of the ordinary students in Polytechnica, except that there the number of occasional students who attend under dispensation is much larger. None of those whose opinions will probably affect the decision arrived at appear to contemplate any material relaxation of this rule, so far as the principle is concerned of rigorously exacting adequate fitness for entering with profit on the higher course of instruction. The demand for change comes in the main from the directors of the polytechnic schools, and others who are chiefly interested in promoting scientific education in its application to manufacturing industry. These say that the success of the *Polytechnica* depends on the existence of good schools in which boys can be prepared; and they complain that the *Gymnasia* are too exclusively classical, that they do not teach mathematics well, or to a sufficiently high point, and that natural science is either altogether neglected, or poorly taught. The *Real-Schulen*, on the other hand, they say, are, for the most part, schools of an inferior order, not so well officered, and holding much lower rank in public estimation. They advocate, as the only sufficient remedy, the general establishment of a new class of schools, to be called *Real-Gymnasia*, to take equal rank with the old gymnasia, and in which pure and applied science shall have the same pre-eminence which classics enjoy under the present system.

That there is great ground for the complaints made cannot be doubted. It is not, however, so clear that the remedy proposed is either *necessary* or likely to be really *effective*.

It is not likely to be really effective. The tendency, already noticed in some of the new science institutions for older students, to merge the strictly educational and disciplinary aspects of science in its practical applications could not but be strengthened by the complete separation of the two lines of culture in the schools. In fact, it is generally admitted that the *Real-Schulen*, which have been in thorough operation for about half a century, have not well fulfilled the hopes entertained of them, and the experience so far supplied by the few *Real-Gymnasia*, the general introduction of which is demanded by some, does not, in the opinion of many most competent witnesses, hold out promise of greater success.

Again, we believe that it is to the full as important in the interests of those who are to enter the universities, that a much more thorough discipline in mathematics, and even in the elements of physics, should be introduced into the old gymnasia, as that the future students of the polytechnica should receive some classical culture with their more extended training in mathematics and physical science. Hence it follows that the establishment of the proposed exclusively scientific gymnasia, undesirable in itself, is not necessary for the purposes aimed at. The great preponderance of authority, with which our own conviction agrees, we found to be against the introduction of the new schools, and in favour of such a modification of the existing gymnasia as that, while the training should be identical for all boys up to a certain stage, in the two highest classes a *bifurcation* should be made—boys designed for the University entering what we may call the *classics side*, and boys designed for the Polytechnic entering the *science side*. The teaching in the lower and middle parts of the school would, at the same time, be so modified, that both sets of boys would get some of the old and some of the new culture. What the character of this modification should be we will state in the words of Prof. Köchly, of Heidelberg, the eminent Greek scholar and director of the philological seminary in that University, by whom the proposed solution was explained to one of us—(1) a teaching of classics, not less thorough, but with some degree of limitation; (2) a much more extended development of mathematics; (3) the introduction of natural science, in its essential and characteristic principles; (4) systematic instruction in modern languages.

Such a system is now under consideration in some parts of Germany. Under it the newly-introduced *Real-Gymnasium*, or High Science School, would be absorbed in the old gymnasia, or grammar school, and on the other hand, the *Real-Schule* would, probably, be amalgamated with the *Ober-Bürger-Schule*. To do away with this incessant multiplication of schools would itself be a great gain, and many of our advisers were strongly in favour of the consolidation.

We have already quoted the emphatic opinion of an eminent classical scholar (Prof. Köchly), in favour of the introduction into grammar schools of more mathematics and some physical science, with a consequent limitation of

the amount of the classical work. On so important a question it is worth while to give the not less emphatic opinion of some eminent men of science in favour of the retention of much of the old classical discipline in the school training of those who are to devote themselves to the study of science.

Prof. Hofmann sees the best safeguard against the vulgarizing of science, when taught with too special a regard to its applications, in a radically sound school-training; and from this point of view he believes the old classical gymnasia system to be of inestimable value. In scores of instances he has seen youths, who have come to his chemistry class (in the University of Berlin), with scarcely a knowledge of the name, but who had been well trained in a gymnasia, and who, after a year, have completely outstripped comrades who have brought with them from school a considerable amount of knowledge (so called) of the elements of chemistry.

Prof. Dove (a no less celebrated name) does not attach much value to the movement for founding *Real-Gymnasia* of equal rank with the ordinary gymnasia. He protests against the separation, and thinks it certain to be attended by inferior teaching and discipline in the new schools.

Prof. Kopp, of Heidelberg (professor of chemistry), thinks that the regular gymnasia education fits a man well for subsequent scientific work at the University. Men thus trained soon outstrip those who come up with an indifferent training from a Real or Polytechnic School. The best preparation at school for a scientific education is a thorough mathematical training, up to the differential calculus, giving exactitude and facility of work to the pupil.

To these weighty opinions from men of the highest scientific eminence we may add the judgment of Prof. Trendelenburg, perhaps the most eminent of living logicians. Dr. Trendelenburg, formerly Rector of the University of Berlin, has been a member of a small commission of inquiry on this very head. He doubts the wisdom of the change recommended by some of opening the University to scholars from the Real schools, and believes that the Gymnasium can be so modified as to meet all the real requirements of the new studies. He informed us that Mitscherlich, Prof. Hofmann's predecessor in the chair of chemistry in Berlin, had expressed to him the same conviction as that of Dr. Hofmann—that the Gymnasium training was superior even for those who are to be science students; and this judgment Dr. Trendelenburg declared that he himself shared.

Most striking evidence of this alleged superiority of the old to the new schools, in method and discipline, is furnished by the significant fact told us by Prof. Kübler, Director of the Wilhelm's Gymnasium (the second in size and importance in Berlin), that in Real schools not more than 1 per cent. of the boys stay long enough to reach the first class, while in the Gymnasium as many as 10 per cent. reach that stage, and he did not think that there was any such difference in the social rank of the boys as to account for this.

On the other side, we heard from Dr. Reuleaux, Director of the Gewerbe-Akademie (or Polytechnic School) of Berlin, and from Prof. Zeuner, of the Polytechnic School at Zürich, an opinion that the *Real-Gymnasia*, or some corresponding scientific high schools, were desirable. Prof. Zeuner, however, allowed that the bifurcation system in the higher classes of the Gymnasium would, if fairly worked, meet the requirements of the polytechnic institutions.

But the weightiest authority in favour of the two sets of schools was that of Prof. Helmholtz, the very eminent physicist and physiologist of Heidelberg. His reason is a striking one:—"Philological culture has an ill effect on those who are to devote themselves to science; the philologist is too much dependent on authority and books; he cannot observe for himself, or rely upon his own conclusions, and having only been accustomed to consider the laws of grammar, all of which have their exceptions, he cannot understand the invariable character of physical laws. Hence," he concluded, "it is a great point to have in the foundation, on equal terms, of complete academic institutions for science, a counteraction to the tendency of classical men to lean on authority alone."

To this thoughtful remark of Prof. Helmholtz the greatest respect is due; but it appears to us that from our point of view it tells directly *against* the establishment of two sets of schools. The object being to arrive at the best system of academic culture, and of school preparation for it, it is surely wise neither to deprive the philological boys of the counteraction supplied by science for the besetting sins of an exclusively classical training, nor to deprive the young students of science of the advantages which may surely be allowed to belong to some measure of the discipline of letters. Indeed, his objection vanishes if the classical

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31 March 1871.



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schools are remodelled in the way proposed, and if equal honour is secured to both sides.

It should be added that the bifurcation system has been tried, with excellent results, in more schools than one. Conspicuous instances of its success are the Wilhelm's Gymnasium, which we visited in Berlin, and the Friedrich Wilhelm's Gymnasium at Cologne, described by Mr. Matthew Arnold.

#### VI. Relations existing between State Governments and Academical Bodies.

In the German Universities, as we have already said, the professors are servants of the State. Respect, however, on the part of the Governments for the dignity of the Universities, and a genuine concern for their efficiency, combined with the force of public opinion, prevent, for the most part, any practical interference with the freedom of the professors. The mode of appointment, at least in Prussia, is as follows:—When a vacancy has arisen, the professors of faculty are invited to name the most suitable person to fill the vacant chair. The Minister of Education is not bound to follow the advice of the faculty, but he generally does so; in case, however, of any difficulty as to the appointment, either on the part of the minister or on the part of the person designated, the faculty is invited to propose a second, or even a third. Once appointed, the professor, in concert of course with his colleagues, selects his own subjects and hours of lecture. There is not even any definite obligation on him as to the precise number of his lectures; but public opinion, and his oath to do all that can promote the success of his office, are ordinarily found sufficient. In Germany this system on the whole works well. The professors who form the faculty exercise their function with the deepest sense of their responsibility in doing so; and so well is this understood, that this formal invitation to a person to take a vacant chair (the *Ruf*, as it is called), even though, for whatever reasons, the appointment be not made, is treated as an honourable testimony to worth and learning, and as a rule receives some acknowledgment on the part of the State, either in dignity or stipend. In Germany this system exists under the most favourable conditions. In the course of centuries satisfactory mutual relations between Governments and Universities have had time to form themselves, and the numerous Universities are eager candidates for the services of the most distinguished professors.

#### VII. Seminaria, &c.

Our report would be imperfect as regards the object of this inquiry without some reference to the *Seminarium*—a characteristic institution of the German Universities, which we believe might in some form be introduced with great benefit into this country. The ordinary lectures of the professors being continuous discourses and the students being *hearers* only, and not subject to any oversight as to attendance and industry, it is found that this system does not suffice for the training of those who are themselves to be teachers. To meet this want the *Seminarium* was established. A limited number of students, whose merit and adequate preparation are ascertained, are in the Seminary drilled in the manner usual in College lecture rooms in England, but with the special object of qualifying them for original investigation and for the higher teaching posts. The most distinguished professors of the University conduct these classes; admission to them is frequently regarded as a high privilege; and regular attendance and due performance of the exercises given out follow as a matter of course. There are often two sections, an upper and a lower; and the members of the upper section take part in the instruction of those of the lower. The Seminaries are State foundations, and to the regular members (whose number is small) the fees are very low, or are even entirely remitted, and to the more distinguished students small exhibitions are given. *Seminaria*, at first limited to theology and philology, are formed for most of the leading branches of study; as, for instance, the Philological Seminarium, the Mathematico-physical Seminarium, the Historical Seminarium, &c. It is obvious that the chemical and physical laboratories also perform the functions of the Seminarium. At Owens College this system is virtually in operation as far as is possible with the limited teaching power which we at present possess.

We have had occasion to mention many characteristics of the German Universities which appeared worthy of imitation by us. It is right to notice that there are two institutions of our own Universities which some of the most enlightened professors of Germany earnestly desire to introduce among themselves; (1) the provision of exhibi-

tions or scholarships, to enable young men of merit and promise to go through a longer course of study, and (2) the provision of halls of residence in which those students who might seek such accommodation could live and carry on their studies under fitting superintendence. Authorities as eminent as Prof. Trendelenburg, of Berlin, Dr. Döllinger, of Munich, and Prof. von Sybel, of Bonn, agree in wishing to see these English institutions grafted on the University system of Germany. Professor Trendelenburg would warmly approve of a system under which a common ground of instruction in literature and science should be provided for members of all religious confessions, while in halls provision should be made for theology and the studies subordinate to it. Such provision exists at Berlin for Roman Catholic and Protestant students of theology; and he thinks that lay students should have corresponding provision made for them, though of course none should be obliged to resort to it. "If anyone," says Prof. von Sybel,\* "is inclined to reject such a proposition as an innovation opposed to the spirit of the age, let him first behold with his own eyes how much there is in the outer life of our students injurious to health and physical strength, and therefore injurious to industry and mental vigour, and then let him judge what benefits judicious measures in this direction would bring with them." The arrangement contemplated by Prof. von Sybel is probably such as that desired by many in connexion with Owens College—the foundation, whether by individual benevolence or by the contributions of any religious body, of halls (in close alliance, but not organically connected with the academic system) which would offer convenient residences, under fitting tutorial superintendence.

#### VIII. Conclusions.

The general conclusions to which we have arrived are as follows:—

1. That the thorough efficiency of an institution such as Owens College, in its proposed extension, demands a subdivision of each leading subject more complete than is usual in England, and a provision for the scientific departments far more elaborate.

2. That consequently, great as are the objections to complete dependence on the State as witnessed on the continent, some measure of aid from the national exchequer, at least in the case of new foundations, and especially for schools of science, becomes almost a necessity. Such aid would be further justified by the means which institutions of the kind would possess of training science teachers of a high class for primary as well as secondary schools.

3. That in order to ensure the lasting efficiency of such institutions as Owens College it is important strictly to maintain their university character and organisation, and this with a view to the interests not only of abstract science, but also of its applications to the arts and manufactures.

4. That the acknowledged success of the German University system, and of the Polytechnica, is intimately bound up with the strict preliminary training of the old Gymnasias and other secondary schools; and, in like manner, in England the permanent and widespread usefulness of institutions for the higher education will mainly depend on a corresponding amount of efficiency in secondary schools.

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Owens College, December 1868.

7390. (*Mr. Samuelson.*) Would you state to the Commission what is the distinction between the instruction in science of the University and that of the Polytechnic School in Germany, both as regards its nature and its objects?—As regards the instruction given in my branch of science, that of chemistry, I do not see that there is very much difference between the University and the Polytechnicum. It is true that in the latter set of schools certain courses on technical chemistry, or on the applications of chemistry to the arts and manufactures, are made important, whereas these are generally subsidiary, though, as is shown by the case of Professor Magnus, who was the professor of technology in the University of Berlin, not altogether neglected in the case of the universities. I do not, as far as my subject is concerned, see why the University lectures should not equally well serve for the students of the Polytechnicum, who are probably destined subsequently to apply the science to some branch of manufacture, as to the University man.

\* Die Deutschen und die Auswärtigen Universitäten, p. 30.



Indeed the pharmacist (a purely technical student) must by law attend the University lectures, and not those of the Polytechnicum. From conversations which I have had with a great number of scientific and other persons in Germany, I believe that the distinction between the Polytechnica and the Universities is to be found in the Engineering courses which are not given anywhere in the Universities, but which form what we may term the staple article in the polytechnic schools. With regard to chemistry, I should be inclined to say that the greatest and most important discoveries in the applications of the science to the arts and manufactures have not been made by men studying for the sake of the applications of science, but have been made by men who have been thoroughly instructed in the highest way in pure science. Thus, for instance, the late discovery of the artificial production of the colouring matter of madder was made by study in a laboratory, which although in the Gewerbe-Akademie in Berlin is specially devoted to the study of purely organic chemistry, without any idea of its application to the arts, and examples might be multiplied. I believe that for engineering those schools have proved very valuable, but I really think that their peculiar characteristic has not been the teaching of chemistry in any more technical form than is found in the Universities.

7391. Are you of opinion that the selection and specialisation of branches of chemistry is carried too far in the German Polytechnica as compared with the Universities?—No, I am not inclined to think that it is carried too far. What I see is that there is no very great difference between the teaching in the Polytechnica and the teaching in the Universities on my subject. But it is in the Universities that the important schools of chemistry have always been found—at Giessen, Berlin, Bonn, Heidelberg, Leipzig, &c.; and in the few cases where a Polytechnic School has been celebrated for its chemistry, it has been for purely scientific studies, as those of Rammelsberg and Baeyer at the Gewerbe-Akademie of Berlin.

7392. So that in point of fact the Polytechnicum is characterised rather by the absence of something rather than the presence of any distinguishing feature, namely, by the absence of literary instruction?—Yes; and I feel strongly that the model upon which our schools of science should be based is the University rather than the Polytechnicum.

7393. (Sir J. P. Kay-Shuttleworth.) You are so well acquainted with the condition of the applications of chemistry to the arts in Lancashire, that I would venture to ask you whether something intermediate between the instruction in your classes of chemistry in Owens College, and the ordinary colour shops might not be of advantage to the persons who generally take charge of the practical departments in the manufactures?—Of the very greatest advantage.

7394. Have you formed for yourself any conception of the exact kind of instruction in the practical applications of theoretic chemistry obtained by your lectures, and the practical manipulations which would be of advantage as a stage of transition to the ordinary colour shops?—The matter is a very difficult one. The only mode of getting scientific principles introduced into the workshop is by beginning with the youths who are to apply themselves to these special branches. We cannot expect to do very much with the men who are at present employed; in the first place, because they have no idea of the principles, and, therefore, they to some extent distrust scientific education; and, in the second place, because their time is very often more than sufficiently filled. I believe, therefore, that it must be a gradual change to get to the actual artizan, and I believe that the introduction of science teaching in the elementary schools is the first step to take in this direction.

7395. But if you had the training of a young man, your conception would be that you would first give him a practical knowledge, and, as opportunity served, give him the theoretic chemistry?—Decidedly.

7396. And then, secondly, that you would give him some means of instruction in the application of theoretic chemistry to the practical arts of the district?—Quite so.

7397. You would not transfer him at once from his theoretic studies to the superintendence of a lot of un-instructed artizans in a colour shop, without some intermediate stage?—I have no doubt that an intermediate stage would be very beneficial, both to the artizans and to the man placed over them, but I cannot form to myself at the present moment an exact idea of how that is to be accomplished, though I am inclined to think that some plan based upon the system adopted by the Science and Art Department, or by an extension of our courses of evening instruction in Owens College for the Lancashire district, might answer the end you have in view.

7398. You are thoroughly aware that men, like John Mercer, at the head of colour shops in Lancashire have by their own unaided efforts acquired a complete knowledge of theoretic chemistry, and have become invaluable in the management of such colour shops?—Invaluable certainly, but, from want of any system, such cases as the one you quote have been extremely rare.

7399. And they have been the foundation of the greatest fortunes that have been made in calico printing in that district?—Not a doubt of it; though it must be admitted that some of the largest and most successful concerns in this trade are carried on with little or no professed scientific knowledge, whilst others with which men of scientific attainments have been connected have proved failures. I mention this only to show (what in fact must be evident) that, after all, business habits and acquirements are essential to success, whilst scientific knowledge, although valuable, is in some cases dispensed with.

7400. If, therefore, the distance between the mere traditions of a colour shop and the theoretic instruction in your classes and laboratories could be bridged over by some intermediate stage, it would be of enormous advantage to the manufacturers of Lancashire?—I believe so.

7401. The difficulty is to devise what that stage should be?—Quite so.

7402. (Professor Smith.) You have insisted very strongly on the importance of the plurality teachers, if I understand you rightly; could you tell us how in the German Universities, to which you have referred, it is arranged that the teaching given by those professors should not clash with one another?—The system of teaching in the German Universities is one quite peculiar to itself. There are three grades of professors, or rather of teachers—the professor ordinarius, the professor extraordinarius, and the privat-docens. As a rule there is more than one professor ordinarius of the particular subject; for instance, at Heidelberg, there are no less than three professors ordinarii of the science of chemistry, and they, as a rule, arrange between themselves, so that their classes may not clash, or else one professor lectures to the medical students whilst another is attached to the Faculty of Science. On the other hand, the professors extraordinarii and the privat-docenten compete with the other professors, and to this system of wholesome competition it is that in my mind the great value of the instruction in Germany is due. The older men are kept up to the mark by knowing that fresh blood is constantly being brought to bear upon their subject, whilst the younger men are, by the force of example, and looking up to the older teachers, compelled to treat their subjects from a high point of view.

7403. Is it found that there is any danger that this system of having many professors lecturing on the same subject leads to too great a speciality in the character of the lectures?—I should say not in Germany, but I do not at all wish it to be understood that I should propose that this German system should be fully carried out in England. I do not think that the system probably would be a natural one for us, or that we are ripe for it, and I only wish to point out

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how very much more attention is paid to the teaching of scientific subjects in Germany than in our own country.

7404. Has it occurred to you to suggest any means by which in this country you could obtain the advantages of a plurality of teaching, without, what I understand you to refer to, the disadvantages that there might be in this country from adopting it?—I think that care would have to be taken in the adoption of the plurality system, so that in the case of two professors of the same science the lectures should not be allowed to interfere, and, in fact, I should always advise that the direction of the department, for instance of chemistry or of physics, should remain in the hands of one head professor, whilst the assistance which was necessary should be given probably by subordinate men. As Mr. Greenwood has told you, we have found it necessary to subdivide our professorship of natural philosophy, but we have thought it advisable to appoint Dr. Stewart as the director of the laboratory, although the gentleman, Professor Core, who has been appointed his coadjutor has an independent position. In the University of Oxford and in several of the London Colleges a similar division in the Chairs of Natural Philosophy has been made.

7405. In a similar way you might deal with other subjects, if it became necessary?—That is my opinion.

7406. With reference to the annual cost that you named for certain German laboratories, sums of 500*l.* and 600*l.* a year, you said that that excluded the payments to the professors, but did it include the payments to the assistants and demonstrators in the laboratory?—It included all payments except the payment of the salary to the professors. The payments made to the assistants are very small in Germany. The assistants are generally chosen from the best or most promising or best qualified students. They are also State servants, as all professors are, and receive salaries from the Government amounting to from 40*l.* to 60*l.* per annum, with the addition of a residence, fire, and so on. The sum which we have to pay for skilled assistants is very much higher, probably double or treble as much as they pay in Germany.

7407. (Chairman.) Are you of opinion that special needs exist in the South Lancashire district for scientific instruction of the highest kind?—I am. I believe, in the first place, as Manchester or South Lancashire is the centre of a district in which a variety of the most important national industries are carried on which depend on the application of scientific principles, that a knowledge of those laws and principles is necessary in order that such industries should flourish and grow. To take one single example, I may mention that Manchester is the seat and centre of the largest chemical trade in the kingdom, and that the produce of the chemical manufactures within a radius of 20 miles around Manchester is of the value of 1,000,000*l.* sterling per annum. There is a great need of well-trained chemists to carry on these works, to analyse the various products and the various raw materials, and especially to keep up the character of the manufacture; and also, which is another most important point, to introduce improvements and to bring about changes in the processes. Up to within a few years chemical manufacturers took into their laboratories and into their works young Germans who were well educated in the Universities or polytechnic schools of Germany. They did not do this in preference to taking Englishmen, but because they could not find Englishmen qualified to undertake the work. Many students from the laboratory in Owens College now occupy positions of trust in the various chemical works in the district, and by degrees we are filling up those posts with young men who have been scientifically trained. I am frequently asked by the manufacturers to furnish young men able to carry out their work. Not only have we the great alkali trade in our district, but it is the centre, as Sir James Shuttleworth has hinted, of the calico printing

industry, of dyers, ironmasters, bleachers, coal miners; and all these, and many others, have need of chemistry and of scientific instruction.

7408. Do you find that there is a considerable demand for such instruction on the part of aspiring artisan candidates?—I do. Professor Greenwood has already, I think, pretty fully exhausted that point. I may say that frequently young men who have been artisans come under our notice. I have had several in the laboratory, and I always find them really the best students, because they come with a determination to make the very best of their opportunities. I may call your attention to Mr. Snelus, the gentleman whose name I had to mention the other evening at the meeting of the Iron and Steel Institute. He was an ordinary schoolmaster, who came to Owens College for scientific instruction, and he then obtained one of the Queen's prizes, and ultimately one of the scholarships at the Royal School of Mines, and is now holding an important position at the Dowlais Works, and will, I believe, turn out to be a man of considerable ability.

7409. He was trained under you at Owens College, was he not?—He began his training under me; he did not follow it out altogether with me, but went to the Royal School of Mines, as he designed to follow out the special branches of metallurgy and mining, subjects which we are not yet prepared to teach. We had also a pupil who came as one of our Whitworth Exhibitioners, who is the son of a blacksmith, and who afterwards took one of the Whitworth Scholarships, standing, I think, high on the list. We had also a man who stood highest on the list of the Whitworth Scholars this year, who was a *bonâ fide* working man, and he was placed on the list of students. You are aware that the scholarships are divided into two classes, one for the workmen and the other for the students, and one of our *bonâ fide* working men pupils stood second on the list amongst the students, competing therefore not with his fellow workmen, but with the students from all England, who had had much better opportunities, and yet the gold medal was awarded to him in pure mathematics. Then, in the next year, the following of our men got Whitworth exhibitions: Taylor was the second, Griffiths third as a student, and Tomkins the first and Dodgson the second as a workman. There are only 10 of those exhibitions and scholarships of 100*l.* each given by Sir Joseph Whitworth every year. Four of our own men got them this year, and three got them out of the 10 the year before. First, second, and fourth in the first year; and the second and third in the students' list, and the first and second in the workmen's list last year.

7410. Are those scholarships confined to artisans?—Half are adjudged to artisans or persons who go in as workmen, and half to students. The gentleman who was mentioned by Mr. Greenwood as being the senior wrangler this year went in, and got the second scholarship last year. I think that on the third head, upon the endowment of scholarships, probably Mr. Greenwood's statements have been sufficient.

7411. Are the artisans who become students at Owens College generally young men?—They are not generally very young; I should say that from 20 to 22 was their average age.

7412. Can you give the Commission any information as to the means available for encouraging the study of science in its higher branches?—In my department we have the Dalton chemical scholarships for original research in chemistry, for which the sum of 4,125*l.* was placed at the disposition of the Trustees. This is a most valuable and important scholarship, which was founded at the suggestion of my predecessor, Dr. Frankland, in 1857. No less than eight students since the year 1857 have been elected Dalton scholars, and have published certain original investigations of more or less importance, adding more or less to the knowledge of the science. Those men have most of them now taken high positions, either in manufacturing industry or in theoretical pursuits, and



these scholarships in my branch act as a most important inducement to continuous study. Our other means of inducing men of very small means to prosecute a continuous system of scientific study are exceedingly imperfect. In fact, the only ones are the Rumney scholarships referred to by Mr. Greenwood, and in this case, as in many others, in order to assist the students, the professors have foregone all charges on the admission to their classes. I mention this chiefly to point out the want of something of the kind.

7413. How long is the Dalton scholarship tenable?—The Dalton scholarship is tenable for two years, one of which must be spent in the laboratory of Owens College, and the other in the laboratory of some other English or continental University or College to be approved of by the Trustees.

7414. Is there much competition for those scholarships?—There has not been much competition for those scholarships. The difficulty of getting young men to stay for that length of time, and to devote themselves to original research, is, as everybody knows who has had to do with it, exceedingly great, nor indeed are the majority of young men qualified to carry out such investigations. I beg to put in a list of the researches of our Dalton scholars (*given in the subsequent list of papers*).

7415. Do you require any preliminary proof in the candidate, of capacity to engage in original research?—That almost entirely is a matter which one must judge of by the knowledge that one has of his pupil previously; all those men must have previously gone through a complete course, either with me or elsewhere.

7416. Are you the examiner for those scholarships?—I am the sole examiner.—The candidate has also to pass an examination in theoretical chemistry, but he must of course be excluded from competition if he shows obvious incompetency to conduct original chemical investigations. He also must give proof of such an amount of mathematical knowledge as qualifies him for the higher studies in chemistry.

7417. Do you think that the foundation of additional scholarships would be a very great advantage to Owens College?—I most certainly think so, but I would rather leave the foundation of scholarships to private munificence than to have any organised scheme of Government scholarships.

7418. Will you be so good as to put in the communication which you have had from Professor Balfour Stewart?—As the Commission are aware, he has only just recovered from a severe accident, and he writes thus: "The only hints I have to offer are "with regard to the physical laboratory. In the "first place I quite think that institutes which provide "physical laboratories in which experiments, &c. fitted "to extend knowledge may be made as well as the "professors who make the experiments have a pecuniary claim upon a Government anxious to promote "science, but I cannot see at present how this is to be decided. The next point is with regard to the "investigations which may be carried on in such "laboratories. These are of two kinds—experiments "and observations. First, as regards experiments, "I think that a body similar in constitution to the "Government Grant Committee of the Royal Society "should have the disposal of a sum of money larger "than the yearly 1,000*l.*, which it has at present. "The director of a physical laboratory having fixed "upon a research, and calculated the cost of pursuing "it, would then make application to the Government "Grant Committee, and if they regarded the research as likely to promote knowledge, and had "confidence in the applicant, they would vote him a "sum of money to be expended in the experiment." That, I presume, is simply going on the same ground on which the existing grant is at present made. Then with regard to observations, he says, "A physical laboratory might, in like manner, take part in "the observational science of the country. In doing "so it would form part of a system, and would "require (in so far as these observations were con-

cerned) to be subject to certain regulations. The "expense of such observations would not be, of course, "borne by itself, but by Government. Besides making "regular observations, the director of a physical "laboratory might wish to discuss his own and other's "observations. Such a discussion would involve time "and money. Thus, for instance, if I wished to discuss after a particular manner the observations of the "Meteorological Committee I should first have to apply "to the Meteorological Office for a manuscript copy of "their observations, which would cost money. I should "next have to reduce these myself, which would cost "great time, if I could afford that; if not, money "again. Now it is evident that before observations "can be fully utilised, all those who are interested in "the subject, and also competent, should have the opportunity of discussing such observations with the "view of making discoveries. I think, therefore, that "the board above alluded to as similar to the Government Grant Committee of the Royal Society, besides "encouraging experiment, should have the power of "voting money to competent men" (and he mentions one) "who may wish to reduce, after a particular "method, certain portions of the observations of a "country with the view of making discoveries, for as "long as the power of operating on observations is "practically limited to the individual or committee "charged with superintending these observations, we "shall not do a bit of good."

7419. (*Professor Smith.*) Do you know any other foundation in England of the same character as the Dalton scholarship for the encouragement of original research?—No. I believe that there is no scholarship or fellowship given for the promotion of original scientific research in the Universities. In order to obtain the Dalton scholarship original experiment must be made, and the research is printed in the College Calendar, as well as communicated to some scientific society. Then the student holds the scholarship, which is 50*l.*, for two years, and may either continue his experiments or his work at Owens College, or he may continue it elsewhere.

7420. But he is not bound to engage in original research during that period?—No, he is not bound to engage in original research, though it is necessary for him to continue his scientific education, but the scholars have frequently published other investigations during their tenure of the scholarship. The terms of the holding are wide. I am not aware that a similar scholarship exists elsewhere. I may mention, as an example, that one of the Dalton scholars, Dr. T. E. Thorpe, who now is Professor of Chemistry at the Andersonian University in Glasgow, made some very important experiments on the chemical action of light on the coast of Brazil, and the results were published in the Transactions of the Royal Society. Two other of my Dalton scholars have taken good positions already. Dr. Marshall Watts (D. Sc. Lond.), who is science master in the Manchester Grammar School, is doing much to strengthen the position of science teaching in schools, and Dr. Wright (D. Sc.) is lecturer on chemistry in St. Mary's Medical School, Paddington. These men would probably have been unable to devote themselves to science if they had not obtained our scholarship.

7421. (*Chairman.*) Do you hold it to be important that the teachers of such branches of science should be themselves investigators?—I consider that it is of the greatest importance.

7422. Will you give your reasons for considering it to be a matter of great importance?—I consider that the main object in the highest form of science instruction is to form a school in the scientific sense of the word, and I believe that the best way of impressing upon the minds of the students the true dignity and importance of science is by bringing them into contact with men who are themselves engaged in widening the boundaries of knowledge. In order to show that we have endeavoured from the commencement of Owens College to act up to these ideas, I beg to hand in a list of the original investigations which

H. E. Roscoe,  
Esq., B.A.,  
Ph.D., F.R.S.

31 March 1871.



*H. E. Roscoe, Esq., B.A., Ph.D., F.R.S.* have been made in the laboratory of the College, first under Dr. Frankland's direction from 1851 to 1858, and since that time under mine.

31 March 1871.

LIST OF PAPERS published from OWENS COLLEGE LABORATORY.

1851.  
(1.) *Frankland*.—Contributions to our knowledge of the manufacture of coal gas.
1852.  
(2.) *Frankland*.—On a new series of organic bodies containing metals. *Phil. Trans.*, 1852.
1853.  
(3.) *Frankland*.—On shale from coal pits.  
(4.) *Frankland and Ward*.—Apparatus for gas analysis.
1854.  
(5.) *Frankland*.—On illumination.
1855.  
(6.) *Frankland*.—Researches on organo-metallic bodies, No. 2. *Phil. Trans.*, 1855.
1856.  
(7.) *Frankland*.—On the history of organo-metallic bodies. *Phil. Trans.*  
(8.) *Frankland*.—Researches on the organo-metallic bodies, No. 3.  
(9.) *Frankland*.—On a new series of compounds derived from ammonia.  
(10.) *Guthrie* (Assistant).—On the sulphovinites and amylophosphoric acid.
1857.  
(11.) *Frankland*.—Researches on the organo-metallic bodies, No. 4. *Phil. Trans.*, 1857.  
(12.) *Frankland*.—Note on sodium ethyl and potassium ethyl.  
(13.) *Guthrie*.—On the action of light on silver chloride,  
(14.) *Guthrie*.—On iodide of acetyl.  
(15.) *Guthrie*.—Contributions to our knowledge of nitrite of amyl.  
(16.) *Guthrie*.—On the preparation of the double ethers.  
(17.) *Bunsen and Roscoe*.—Photo-chemical researches, Parts I., II., and III. *Phil. Trans.*, 1857.
1858.  
(18.) *Guthrie*.—On a new aspirator.  
(19.) *Hobson* (Student) (Dalton scholarship investigation).—On a new series of organo-thionic acids.  
(20.) *Hobson* (Student).—Second memoir on the same subject.
1859.  
(21.) *Bunsen and Roscoe*.—Photo-chemical researches, Part IV. *Phil. Trans.*, 1859.  
(22.) *Roscoe and Dittmar*.—Absorption of hydrochloric acid and ammonia in water.  
(23.) *Guthrie*.—Action of chloride of sulphur on ethylene and amylene.
1860.  
(24.) *Roscoe*.—On the composition of the aqueous acids of constant boiling point.  
(25.) *Dittmar* (Assistant).—On a waterbath with constant level.
1861.  
(26.) *Roscoe*.—On perchloric acid.  
(27.) *Roscoe, Schunck, and Smith*.—Report on chemical industry of South Lancashire.  
(28.) *Roscoe and Clifton*.—On the effect of increased temperature on the spectra of the metals.  
(29.) *Sims* (Student) (Dalton scholarship investigation).—Contribution to our knowledge of the laws of gas absorption.  
(30.) *Hurst* (Student).—On the so-called thioformic acid.
1862.  
(31.) *Roscoe*.—On the composition of the acids of constant boiling point. Part II.  
(32.) *Roscoe*.—Note on perchloric ether.  
(33.) *Schorlemmer* (Assistant).—On the hydrides contained in canal coal tar.  
(34.) *Dancer* (Student) (Dalton scholarship investigation).—On hypobromous acid.
1863.  
(35.) *Bunsen and Roscoe*.—Photo-chemical researches, Part V. *Phil. Trans.*, 1863.  
(36.) *Roscoe*.—On the measurement of the chemical brightness of various portions of the sun's disc.  
(37.) *Roscoe*.—Application of spectrum analysis in Bessemer's process.  
(38.) *Roscoe*.—On the meteorite of Alais.  
(39.) *Schorlemmer*.—On the constitution of the so-called alcohol radicals.  
(40.) *Schorlemmer*.—On the constitution of American petroleum.
- (41.) *Schorlemmer*.—On the derivatives of hydride of heptyl.  
(42.) *Schorlemmer*.—On the action of chlorine upon methyl.
1864.  
(43.) *Roscoe*.—On the water of Bath wells.  
(44.) *Schorlemmer*.—On the identity of methyl and hydride of ethyl.  
(45.) *Dale* (Student).—On the action of caustic baryta on suberic and azelaic acids.  
(46.) *Dancer* (Student).—On the composition of crude wood spirit.  
(47.) *MacDougall* (Student).—On the amount of carbonic acid contained in the air of Manchester.  
(48.) *Watts* (Student) (Dalton scholarship investigation).—On the absorption of mixed gases in water.
1865.  
(49.) *Roscoe*.—On a method for meteorological registration of the chemical action of total daylight. Bakerian Lecture, 1865.  
(50.) *Schorlemmer*.—Researches on the hydrocarbons of the series  $C_n H_{2n+2}$ . Part I.  
(51.) *Schorlemmer*.—Ditto. Part II.  
(52.) *Schorlemmer*.—On the existence of the benzol hydrocarbons in Canadian petroleum.  
(53.) *Schorlemmer and Dale*.—On heptyl hydride obtained from azelaic acid.  
(54.) *MacDougall* (Student) (Dalton scholarship investigation).—On a mode of measuring the relative sensitiveness of photographic papers.
1866.  
(55.) *Roscoe*.—On perchlorate of thallium.  
(56.) *Roscoe and Baxendell*.—Note on the relative chemical intensities of direct sunlight and diffused daylight at different altitudes of the sun.  
(57.) *Schorlemmer*.—On a new series of hydrocarbons from coal tar.  
(58.) *Schorlemmer*.—On amyl compounds derived from petroleum.  
(59.) *Schorlemmer*.—On ethyl-hexyl ether.  
(60.) *Schorlemmer*.—On the hydrocarbons contained in crude benzol.  
(61.) *Wright* (Student).—Contribution to our knowledge of the chemical action of sunlight on sensitive photographic papers.
1867.  
(62.) *Roscoe*.—On the chemical intensity of daylight at Kew and Pará.  
(63.) *Roscoe*.—Researches on vanadium, Part I. Bakerian Lecture, *Phil. Trans.*, 1867.  
(64.) *Schorlemmer*.—On di-isopropyl and amyl-isopropyl.  
(65.) *Thorpe* (Student).—On the amount of carbonic acid contained in air of the Irish Sea.
1868.  
(66.) *Schorlemmer*.—On the oxidation products of the hydrocarbons,  $C_n H_{2n+2}$ .  
(67.) *Schorlemmer*.—On the relation between structure and boiling points of the hydrocarbons of the series  $C_n H_{2n+2}$ .  
(68.) *Schorlemmer*.—On the so-called capryl alcohol.  
(69.) *Thorpe* (Student) (Dalton scholarship investigation).—On the carbonic acid contained in sea air and in the air of tropical Brazil.  
(70.) *Thorpe* (Student).—Analysis of the water of the Holy Well, Humphry Head, Lancashire.
1869.  
(71.) *Roscoe*.—Researches on vanadium, Part II. *Phil. Trans.*, 1869.  
(72.) *Schorlemmer*.—On the derivatives of propan, No. 1.  
(73.) *Schorlemmer*.—On the derivatives of propan, No. II.  
(74.) *Schorlemmer*.—On octyl compounds.  
(75.) *Darling* (Student) (Dalton scholarship investigation).—Researches on di-methyl.
1870.  
(76.) *Roscoe*.—Researches on vanadium, Part III. *Phil. Trans.*, 1870.  
(77.) *Roscoe and Thorpe*.—On the relation between the sun's altitude and the chemical action of total daylight in a cloudless sky. *Phil. Trans.*, 1870.  
(78.) *Schorlemmer*.—Researches on the hexyl compounds.  
(79.) *Schorlemmer*.—On a singular formation of cetyl alcohol.  
(80.) *Jekyll* (Student) (Dalton scholarship investigation).—On the action of sulphuric acid on diallyl.  
(81.) *Morton* (Student).—On the composition of water of the Irish Sea.  
(82.) *Williams* (Student).—On the quantitative determination of phosphoric acid.



7423. How do you consider that the necessary leisure for such work can be found?—I think that it would be very bad economy if, in any system which the Government may undertake for the founding of colleges of science, the strict system of a pound of work for a pound of pay were exacted. I believe it is most important to leave to a teacher the necessary amount of leisure for carrying out original work. If this be not the case the colleges will descend into mere elementary schools, and the professors into mere schoolmasters. The difference between colleges and schools, as regards scientific instruction, lies, in my opinion, mainly in the fact, that the first are centres from which science is extended by research. This necessary leisure can be obtained by what has been carried out to a certain extent in the continental schools, namely, the system of *repetiteurs*, who will undertake a great deal of the mere drudgery of teaching. I have myself to do a great deal of this at the present time, and I feel very much the need of something of the kind.

7424. Do you distinguish *repetiteurs* in any way from assistants?—No; I simply use the word because it signifies what I wish to express—a plan for taking that part of the teaching off the hands of the professors which may be termed actual drudgery. I believe that the system of repetition is most important. I carry it out myself. I am my own *repetiteur*, and I consider it to be a very important mode of teaching.

7425. Will you give us your views as to the encouragement that at present exists for men of ability to take up science as a profession?—I believe there is very little encouragement in the country at present for men of ability to take up science as a profession, and I consider that the best way of meeting this want is the foundation of professorships attached to the high schools of science. It appears to me especially, if Government aid is called into question, that this is a mode in which science and scientific instruction can be practically benefited; because Government can put a money value on science teaching, whilst it is impossible to do so with original investigation; and I believe that, by offering an inducement of position and competence, persons of ability will devote themselves to science, and in this way not merely the science teaching of the country will be extended, but what is highly to be desired, actual investigation and original research, will at the same time be promoted.

7426. You would like to see professorships established with only a moderate amount of work necessarily required from the professor in the way of teaching?—Yes, a moderate amount of work and a moderate amount of pay. I think it would be a mistake to burden him with so much teaching that no time or inclination would be left him for original research; but, as the Government pay him to teach, I should take care that he does his work efficiently.

7427. And do you think that the establishment of other schools of science of a high class is desirable?—I think it is very desirable.

7428. Do you think it is desirable with a view to this special object of encouraging original research?—I consider that the foundation of such science schools by the Government would, in the first instance, be carried out with the object of spreading a knowledge of science amongst the people; but I am sure, on the other hand, that the establishment of such schools must also tend to the increase of scientific research, and I would by all means foster and encourage, on the part of the students, as well as of the professors, a love for original investigation.

7429. Would you desire to see the Government establish such schools entirely at its own cost, without any movement on the part of the population connected with the districts?—I think that the first duty of the Government is to help what is going on. I think that it is a mistake for the Government to experimentalise, and, as a rule, that the regulations laid down in the statements which Mr. Greenwood has made are sound. We have examples of the case of schools being founded which cost a good deal of money, and at which they have very few

students, whilst, on the other hand, there are many science schools doing good work which are crippled, and unable fully to discharge their functions from want of pecuniary aid.

7430. Can you explain more particularly what you mean by the foundation of some schools of science on the model of the German Universities?—What I mean is this, that, in my opinion, it is the German University system which we are to look to as our model rather than their system of polytechnic schools.

7431. What means exist at Manchester for spreading scientific instruction amongst the people?—I conceive that it is a very important subject, but one which is still in its infancy. To begin at the beginning, it is essential that an interest in scientific pursuits and in scientific matters should be incited amongst the people at large, and this may be done by general lectures given to large audiences on strictly scientific subjects. This I have attempted to do in Manchester with some success, thanks to several gentlemen who have been kind enough to come down to help us in this matter, and great interest has been exhibited by the working classes in the subjects. I have here a copy of the little books of lectures which have been published at 1*d*. The nine science lectures for the people which have been given this winter have attracted nearly 9,000 persons. The names of the lecturers, Professor Huxley, Dr. Carpenter, Dr. Huggins, Mr. Lockyer, and many others, are a sufficient guarantee of the really scientific nature of the instruction given; and I think that if this plan of penny science lectures were systematized and made general in our large centres of population, a good foundation for science instruction would be laid. The difficulty is the expense attending these lectures, which can by no means be defrayed by the penny entrances. A gentleman (Mr. J. P. Jodrell) has generously defrayed the cost of the lectures this year, amounting to 100*l*. If these science lectures for the people were systematized, I do not think that there would be much difficulty in getting the necessary funds by subscription from the localities. The next point is, how are we to get science instruction, properly so-called, begun? The science classes in connexion with the Department of Science and Art, I believe, are in our district a very important element indeed of scientific instruction. I think that the proposition which has been made by Professor Huxley on the systematization of the scientific instruction given in this way is a matter of the very greatest consequence, leading the people on to the evening classes in Owens College, and passing, if possible, to the more extended courses of instruction in the day classes. This will necessitate, of course, certain exhibitions, or certain moneys, by which the artisans may, for a time, live; the object of the whole thing being to seek and filter out those persons who, by nature, are able to take a high position, but who by birth, or by their place in society, have difficulties in obtaining the necessary instruction.

7432. (*Professor Huxley.*) Will you be so good as to express an opinion as to whether the system of science classes in connexion with the Department is at present worked to the greatest advantage or not?—In answer to that, I should say certainly not. I believe that the science instruction, as given in Lancashire, in connexion with the Department, is still most imperfect. I believe that teachers are, as a rule, I was going to use a strong word, exceedingly ill educated; at any rate, that they are certainly not up to the mark of teaching science properly. Then, as Mr. Greenwood has pointed out, the system of payment on results works certainly well in particular classes, but is fatal to the prosecution of anything like a systematic course; but still I believe that, in spite of all difficulties, and in spite of all shortcomings, which are many, the science classes in Lancashire have been productive of a very great deal of good; still I only look upon it as a beginning, and that now it is quite time to inaugurate a new system.

7433. I see that, in your *Précis*, you speak of extended means of creating a qualified staff of teachers.

H. E. Roscoe,  
Esq., B.A.,  
Ph.D., F.R.S.

31 March 1871.



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31 March 1871.

Do you know what has been done, on a very small scale, in that respect, in having men up to London to be trained in teaching?—Yes, I am aware of that.

7434. Do you think that advantageous?—I believe it is most advantageous, and I should like to see the system carried out very much more fully, and classes of a similar character set up in all localities in which science colleges exist.

7435. (*Chairman.*) Could you briefly give the Commission any advice as to how science classes in connexion with the Department might be rendered more valuable?—I think that, in the first place, it is necessary to create a qualified staff of teachers. I believe that the system of allowing all men to teach who have passed only one simple examination, or the one examination of the Science and Art Department, is a system which cannot work, and I believe that the teachers must be much more thoroughly taught. I think that the science colleges will just supply that need, and that this very important feature in their scheme will be the mode in which they will repay the Government for any aid which the Government might grant. That, in my opinion, is the first essential. With regard to the second important point, viz., systematizing the instruction in the districts, I am not prepared to offer a precise scheme, though I am inclined to think that one founded on the plan we adopt in our day classes in Owens College might be found to work well. What I wish strongly to point out is, that the plan of mere payment on results (and this only for artisan candidates) cannot work, but that if the colleges are to give instruction for nominal fees to artisans, or primary or secondary school teachers, the Government must, to a certain extent, endow the teacherships, still leaving some sort of payment on results in force, to ensure vigour in the teacher.

7436. Can you make any suggestions as to the mode in which Government aid could be best carried into effect?—I do this with the greatest diffidence; but it appears to me that the system of a consultative council,

The witness withdrew.

Adjourned to Tuesday, 25th April, at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Tuesday, 25th April 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
SIR JOHN LUBBOCK, Bart., M.P., F.R.S.  
BERNHARD SAMUELSON, Esq., M.P.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
GEORGE GABRIEL STOKES, Esq., M.A., LL.D.,  
Sec. R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

WARINGTON W. SMYTH, Esq., M.A., F.R.S., further examined.

7440. (*Chairman.*) The Commission have received a letter from you this morning, and they regret to find from the terms of that letter that an idea appears to prevail in your mind that one of the Commissioners, in a letter which appeared a short time ago in the "Times" newspaper, has attributed personal motives to you. The Commissioners have read that letter, and they are unable themselves to see that it conveys any imputation upon your motives, and they venture to hope that upon consideration your opinion may coincide with theirs?—The wording of the paragraph was such that the impression conveyed to most of my friends, as well as to myself, was at the time this, that some of the persons connected with the Museum in Jermyn Street might be actuated by personal motives in giving opinions one way or the other. Personally I am placed in rather a delicate position in this way, because I have made no scruple amongst my friends of stating that my position otherwise was such that I could not remain a Teacher at the School of Mines if it were placed at South Kensington.

to advise the executive on matters of scientific instruction, is the true one. I believe it is a work which it is almost impossible that the executive can do properly without advice received in some form, and that appears to me the form in which it is most likely to be productive of the greatest good.

7437. Have you any suggestions to make as to the constitution of such a council?—I should be inclined to think that a council, formed on the same plan as this Commission, so far as regards the class of its members, would be a very proper one to advise the Government.

7438. Would you think it advisable that the Government should name its own consultative council, or that some of the members should be nominated by the societies?—I should provide for a certain number of scientific men being upon the council, and desire that the Government should nominate (for you may trust the Government to do it with fairness), as well as the societies; that is, the lay members should be appointed by Government, and the professional ones by the various scientific societies. The great duty of such a permanent body would be, to lay down some sort of system, according to which Government aid to science must be given, and to prevent (if possible) the expenditure of national moneys upon ill-considered or one-sided schemes. The results of a systematic Government effort is seen in the case of the German Universities, in which, for comparatively small amounts of national expenditure, great results are obtained, whilst I fear that with us (for want of system) the opposite condition of things more nearly holds good.

7439. You would not desire that it should consist solely of men of science?—No, certainly not. I am of opinion that the presence of the lay element is essential, because many questions will occur which are not purely scientific, such as the necessity for establishing new colleges, or aiding existing ones, and on these points the opinions of experienced (perhaps local) non-professional men would be of the greatest value.

W. W. Smyth,  
Esq., M.A.,  
F.R.S.

25 April 1871.

7441. Since you were invited to attend here the Commission have received information from Sir Roderick Murchison to the effect that a document explaining the views of yourself and certain other Professors with respect to the suggested removal of the School of Mines to South Kensington has been transmitted to the Lords of the Committee of Council on Education. As that document will put the Commission in possession of your views on the subject, we do not propose to ask you any question with respect to the question of removal, but we are still desirous to have your opinion as to the amount of accommodation required at South Kensington for the Professor of Mineralogy and Mining. We have delegated that question to a Committee, and we should be very glad if you would furnish that Committee with your views as to the amount of accommodation required at South Kensington for that professor. We think it would not be convenient to go into the question in detail on the present occasion, but our desire is that you should meet the Committee at South Kensington, and point



out all the requirements on the spot?—I think in a very few words I could state to your Grace what appears to be desirable in this case.

7442. With regard to the general principles of what is required, rather than the actual details, which would entail a reference to the plans themselves, the Commission would be glad if you would state your opinion?—My opinion is that a larger collection of minerals and of metalliferous specimens connected with the occurrence of lodes is desirable than might at first sight appear necessary, because, in a school of mines, the mere lecturer's collection is not sufficient. I could, in a very small compass, take a sufficient number of specimens for lecturing from, and keep them in a very moderately sized room, but in consequence of the vast number of varieties of the species in the mineral kingdom, it is necessary to have a very much larger collection arranged and suitably exhibited for the students to examine, independently of the lectures, or between lecture times. It is for that reason that a larger amount of space would be necessary than one would at first sight perhaps be inclined to grant, but not such an amount as would be incompatible, I imagine, with the space which is proposed to be placed at the disposal of the lecturer.

7443. (*Dr. Sharpey.*) You mean a collection not to be actually exhibited in the lectures, but for reference?—No; not to be actually exhibited in the lectures, but supplemental to them.

7444. There is no museum at Kensington, is there?—They have nothing of the kind there now. It would require either that the British Museum collection should be in an accessible place near the School of Mines, or that there should be a very full and well arranged collection accessible to the students between lectures, at times when they are studying the subject by themselves.

7445. (*Chairman.*) If the British Museum collection were removed to South Kensington, would that meet your views as to the requirements for the study of the subject?—It would, as regards the simple minerals, to a great extent meet the difficulty, and there would then be required only, in addition, a suitable series of specimens illustrating the occurrence of the minerals in the rocks or in the lodes.

7446. Can you give any general idea of the space that the carrying out of that object would require?—I should think that for the first purpose a room 30 feet by 20 would give a suitable space for a mineralogical collection, of course very inferior to that of the British Museum, but it might be confined to something like those limits, and another room, somewhat smaller, for the purpose of exhibiting the occurrence of the minerals in the lodes, or in rock masses.

7447. Do I understand you that, if the British Museum collection were removed to South Kensington and were in the vicinity of the school, a smaller room

than that which you have mentioned would suffice?—No; I should still desire a special technical collection, in a room not smaller than 30 feet by 20 feet. The students have at present the advantage, in Jermyn Street, of being able to consult those collections and study them between the hours of lectures, and on days, perhaps, when there are no lectures going on. Then they have an additional advantage, when they go to the British Museum, of studying there a collection of minerals arranged upon a totally different system, and between the two they are led to study the actual characters of minerals much more closely, I think, than if they had the opportunity of seeing them only in one place. The other two points are, 1st, that suitable space would be required for models. It is, perhaps, a little difficult to say what should be required; but I think that a moderate space, two rooms, say 30 feet by 15 or 20, might suffice, in order, in the course of time, at all events, to establish a collection of a somewhat similar character to those which already exist in Jermyn Street. Then there ought to be a sufficient space, which need not necessarily be large, for the collection of mining plans, and I assume that there would be a scientific library, available for all the different departments.

7448. Have you that at Jermyn Street?—We have a most valuable technical library there, which the students are in the habit of using very much between the lectures as a sort of waiting room and study room.

7449. Are those the principal points to which you think the attention of the Commission should be directed?—Those are, I think, the chief points.

7450. Do you wish the Commission to understand that you would not be able, by meeting the Committee on the spot, to give any additional or more detailed information than that which you have communicated to us this morning?—I might do so, and I should be quite ready at any time to meet the Committee. I might, perhaps, be able to give useful information, because I have seen most of the other mining schools in Europe, and I know pretty well what their aim and object is, and what ought gradually to be brought together as a museum collection.

7451. (*Mr. Samuelson.*) Do you think that diagrams are in some respects more convenient even than models for instruction?—No; I do not think so. There is great difficulty in comprehending many of the pieces of machinery without an actual model, and, in some cases, in fact we find it rather desirable to have a model constructed the full size, that is to say, a working model of an iron apparatus, but constructed perhaps in wood.

7452. Would the same objection apply in the case of students having some acquaintance with mechanical engineering?—Not in the same degree. Undoubtedly a very large proportion of the machinery with which one has to deal, may be sufficiently explained by the aid of diagrams.

The witness withdrew.

NEVIL S. MASKELYNE, Esq., M.A., F.R.S., further examined.

7453. (*Chairman.*) You have been so good as to furnish the Commission with notes of considerable length, referring to a great many different points; some of them it would be quite impossible for us to find time to go into to-day at all events, and, as to some of them, it appears to us questionable whether they are not rather beyond the limits of our inquiry. I will, therefore, omit the earlier points contained in your notes, and go at once to the question of the Government of the new museum, and ask you whether, in your opinion, it is desirable that in the new museum a larger scientific element should exist than is at present the case?—I think it is extremely desirable. I cannot understand a scientific museum being properly governed except by a more or less scientific body. There are a great many duties which devolve upon such a governing body; and, among the first duties of the governing body, perhaps, the most important duty that they have to discharge, is that with

respect to the election of officers and persons employed in the museum. That seems to me to be a very important duty indeed. Then another duty is that of supervision, the supervision which relates partly to the proper discharge of duty by the officers of the museum, and partly to their custody of the things entrusted to them: then, again, there is the control of the expenditure, and things of that sort, so that, altogether, the duties of a governing body are very multifarious, and these would require their being able to estimate properly the qualifications required in candidates for places, while also they must be men who would be able, with some critical power, to scrutinise the operations of the officers; and I do not think that you can get all that done properly unless you have persons who are more or less imbued with scientific knowledge, and sympathy with scientific subjects.

7454. Have you formed any scheme in your own

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25 April 1871.

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25 April 1871.

mind as to what you would consider the right mode of constituting the governing body?—Of course I am in a little difficulty, being, myself, a servant, as it were, of the Trustees, and one would not like to speak quite as if one were an independent person in forming an ideal government for the new museum, altogether irrespective of what exists; but I may refer to what I proposed in 1860, before the Committee of the House of Commons, when I hoped that the museum would have been reconstituted on its present site under a modified form of its present Government. I still think a sensible sort of government would be a government by Trustees, acting simply as a Board of Visitors occasionally coming, on certain days or when they please, and seeing that the things in the museum are properly looked after, and that the officers are discharging their duty: in fact, they would act as a board of visitors, and the administration of the museum might be left more in the hands of a Director or person who would be in constant communication with his colleagues at the head of departments, and who would again be in direct communication with the Government. In 1860 I proposed a form of government somewhat of this kind, but the conditions, in that case, were different. Or, again, with a thoroughly high-class set of keepers, as, indeed, some of them are now, you might entrust the museum to them as a body forming a kind of college, the members of which would act as a check upon one another, and to them you might add other selected scientific persons of eminence; appointing a Superintendent, or Director as chairman over them, or making one of the body in rotation Superintendent, as has been proposed, I see, in the Report already sent in by this Commission with respect to another subject. Then a Crown Minister should be the person to whom they would be directly responsible, and he, in turn, would be directly responsible to the public for the proper administration of the institution. It seems to me that that would be a sensible and practical sort of government.

7455. Do you recommend that the Keepers should be appointed by the officer whom you have entitled the Director?—No; I should certainly recommend that the Keepers should be appointed by a Minister of the Crown. The more responsibility you throw upon the person who appoints the keepers, it seems to me the better will your keepers be. We now, if I may so, lack, to a certain degree, responsibility in the persons who appoint, and that seems to me to be the fault, if there is one, in our present government, and in our present system of appointing officers.

7456. The heads of departments are now appointed, are they not, by the Trustees?—They are now appointed by the three Principal Trustees: the Archbishop of Canterbury, the Speaker of the House of Commons, and the Lord Chancellor are the three persons who appoint to every office in the museum.

7457. And you would recommend that all those appointments should be made by a responsible Minister of State?—I think that would be by far the best mode of appointment.

7458. Of course obtaining the best advice upon the point?—As I said before, obtaining advice from the body, whatever body should be made the general governing body of the Museum, and that person or that body should recommend to the Minister of State certain persons or a person, and the responsibility of appointing, or otherwise, in accordance with such a recommendation, should rest with the Minister.

7459. What are your views with respect to the subordinate appointments?—I have a very decided opinion upon that subject, as regards the necessity of not appointing every man who comes to the museum to be employed there at once an officer of the museum. At present, if there is a vacancy, we will say an assistantship at the museum, the assistantship is at once filled in the manner in which I have mentioned. It is true that, at the end of a twelvemonth, the keeper can refuse to recommend the confirmation of the appointment of such a person where it is obvious that he is flagrantly

wanting in any of the requirements of his position, but it is a very invidious thing indeed for a keeper to decline to say that such a man is fit for his place. The result of that is, of course, that you have men permanently appointed to subordinate places, which are places of very small emolument and small consideration, and you cannot expect to get first-rate men for those sort of places. Ultimately, however, those are the men from whom, on the system of appointing chief officers from inferior officers, you will have to choose your chief officers. That seems to me a very erroneous system of appointment altogether. On the other hand, I believe, if you paid nearly the same sum of money that you pay now to your assistants, and appointed temporarily a certain number of them, making it a sort of privilege and reward, and, in fact, a high advantage, to a man to be selected to be a permanent servant of the Museum, you would in that way get upon the ladder of promotion only such men as you could ultimately look to as being men likely to discharge the duties of a higher place really well. Of course, as it is, there is no disguising the fact that our departments do get some of them more or less choked with men who one feels are not quite the men for the higher places in the museum.

7460. What is your opinion as to the advisability of lectures being given by the officers of the museum?—I gave evidence upon that point in 1860 to the Committee of the House of Commons, and I certainly see no reason whatever to alter the opinion which I then expressed. My opinion was, that it would be a very great misfortune indeed if you were ever to elect a keeper to a department in the museum because he was a lecturer. That is the key to the whole of my position with regard to that subject. I deem it a very great misfortune that, for a museum, a keeper should be appointed simply or chiefly because he was a good lecturer. If he is a good lecturer, and if he has any opportunity of giving lectures, most certainly I would give every possible encouragement to him, because I believe it is a good thing for him and a good thing for the museum, if he is able to impart knowledge by lecturing, that he should have every opportunity of doing so. But the sort of experience and the methodical habits which are qualifications necessary for a good keeper are so very different from the more brilliant and imaginative qualifications that are necessary for a good lecturer in keeping an audience in attention, that I should be very sorry to think that it was to be a very important element in the election of a keeper that he should be a good lecturer. And, therefore, I say that I would make the lecturing on the part of a keeper permissive, but I would not make it compulsory. I would not make it a part of his real duties.

7461. As long as it is permissive, would it not be very difficult to prevent the subject being taken into consideration in the appointment of keepers?—I do not think so, provided that the lecturing was not connected with the actual collection under the keeper's hand. As I said in 1860, I certainly would not have lectures at the museum. I would not have a lecture room and lectures from the collections. I would make the collections what they are, a great repository of material for students to come and work in, and for the scientific world to come to for collation of specimens and investigation, but I certainly would not make the museum a place in which lectures should be given. And one of my chief reasons for that is what I have mentioned; another chief reason is that I believe, from my own experience, that the using of valuable specimens from a collection for lecturing is a very great evil to those specimens: they get seriously injured. You practically, in most subjects, make a special series for your lectures, and, therefore, it is not necessary, as far as I see, to give the main body of your lectures in the museum. Of course, in the case of a person connected with the museum, if he chooses to invite his class to come there and to go round the museum with him, he has admirable opportunities of giving them a sort of sketch view, and making the museum, as a whole, a very interesting and important



illustration of his lecture, but I would certainly not make lecturing in the museum, as a system, a part of the duties of a keeper.

7462. Do I rightly understand you that you would preclude him from formally delivering lectures in the museum, but allow him to make use of the museum for subsidiary illustrations?—I would preclude formal lectures, but I would not preclude him from meeting a class there, and giving them the sort of lecture that many of us have enjoyed from Professor Owen, for instance, in the British Museum, and I have heard very good lectures given there by other persons; a person walking round the museum and illustrating what has been said in the course of his lectures by appealing to the larger or more important specimens around him, and which, by their size or value, it would be impossible to have brought into a lecture room under any circumstances.

7463. As to the admission of students to the museum, are you of opinion that rules should be laid down for their admission distinct from those which apply to the rest of the public?—Yes, I think that, in fact, the museum mainly exists for students. I do not believe that the true test of the value of the museum is the number of people who can be weekly recorded as visiting it. I believe that the true test of the value of the museum is the number of students who usefully study in it, and for them, therefore, I would afford every convenience that I possibly could. I would give them rooms and places in which they could work, and I would arrange the collections with a view to their becoming useful to them and being readily used by them.

7464. How far is that object which you have been referring to accomplished by the present arrangements of the museum?—I am sorry to say that, partly from our unfortunate needs as regards space, and partly perhaps from our general regulations, I do not think that that has been carried out to the degree that it might have been. I know that in my own department, some time ago, I used to have a great many men; in fact, almost all the pupils of the School of Mines used to come there regularly on the private days, but I may say, almost without exception, that they never come now, simply because a very slight friction was put in the way of their coming, by its being required that a letter should be written to the Principal Librarian, asking permission for them to come. Previously to that I admitted them myself. I said that they might come on such a day, and they came. Now, however, properly speaking, they could not come in that way, but they have to write a letter to the Principal Librarian, which has to be countersigned by some one who knows them, and in that way they are admitted: but that little bit of friction, though it is a very simple thing, still is enough to practically prevent their coming, and I do not see them there on private days. They come on public days, but, of course, they can study much better on private days, when, I am sorry to say, I do not see them there.

7465. Was that regulation made in consequence of any irregularities or inconvenience?—I am not aware; it was some few years ago, in Sir Antony Panizzi's time. I told him at the time that I thought it would operate in that way, and it certainly has done so.

7466. Do you recommend that students should be admitted on application to, or on the recommendation of, the keeper of the department?—Yes; I think that the keeper is the best person really to know whether a man is a fit person to be trusted in his department. I think, certainly, that the keepers ought to be allowed at any time to admit students. It might be of course by a card or in any other way, but still the keeper's permission should be enough.

7467. What is your view as to the question of the access of students to the collections, as distinct from that of the public?—I think you must have already received some evidence upon that point, because I know that Dr. Selater has propounded, at any rate in the public newspapers, a method which is very ingenious, and, for light objects, I think would be

very successful; the idea being, that a case is to be, as it were, common to the gallery in front of it, in which the public are, and to the rooms behind it, in which the students may be supposed to be. Then the front is to be hermetically sealed; in fact, is a sheet of glass which is firmly fastened in and rendered air-tight, and the back is movable. And with regard to light objects I believe that that is a perfectly feasible and a very good plan, and I am quite confident it could be carried out with very little money: and it would be possible for a person standing in front of the case to assist a person standing at the back in the arrangement of objects, so that they should be well seen in front—especially in the case of small things like birds, with which Professor Selater is familiar—but, I think, as regards heavy things there would be difficulty in it. Nevertheless, I venture to think that even that might be got over by a mechanical method which I would propose, and which is this: that instead of your merely moving away the back of the case, and having the shelves in front of you on which you arrange the light things from behind, you should move out, where it is requisite, the whole of the case, that the whole case should, in fact, be an iron framework moving upon rather large wheels let into its sides, which might move upon two fixed rails. In that way I believe you could move out the whole of the core, so to say, of the case from the kind of bays in which you would exhibit your specimens. You might stand in front, and arrange it. In exhibiting large masses, you might have some kind of girders to support the massive objects, and then wheel the whole case forward into its place and fasten up the back of your case by means of iron screws to the wall. I believe that in that way, with velveted flanges, you could perfectly succeed in doing with the heaviest specimens what Dr. Selater proposes to do with lighter objects. The expense would certainly be something to be considered, but when you are making a good many of such cases it is merely an engineering question of how it should best be done economically as well as effectively.

7468. Has anything of the kind ever been attempted?—I am not aware that it has. I think we are living in an age when any engineer would give a plan for making such a thing as this, and make it perfectly feasible almost on any scale that you please, and at an expense that would be nothing very tremendous.

7469. Do you think it is desirable that the museum should be open in the evening?—We tried it with the British Museum. I do not know that our comparative failure is a proof that it would not be a desirable thing. I think it is very likely if it were open in the evenings more permanently the people would gradually get accustomed to it; they would know it was open and come there. But certainly, thus far, it has not been a successful experiment in Bloomsbury.

7470. To what extent is it open now in the evenings?—Last year, I think it was open for about two hours, namely, from 6 till 8 o'clock on Mondays and Saturdays.

7471. Was that in summer or winter?—In summer. This summer again it is going to be tried on Mondays and Saturdays, but I cannot tell why it has never succeeded very well. I think the Sunday afternoon opening would be quite a different thing. I believe you would have the place crowded if you opened it on Sunday afternoon.

7472. It is not opened now on Sunday, is it?—No, it has never yet been tried. That is a thing which I look forward to as a great step for bringing the museum before the eyes of the many, if that is a desirable thing, which to a certain degree it is.

7473. When it is open in the evenings, is it necessary to have gas?—No, it is done at the time of year when we get natural light, so that we have not had gas.

7474. Would it be objectionable to require lighting it in the evening?—I am a little at issue with my colleagues upon that point. The Trustees asked us the question some time ago, and I am afraid that I was the only one who was of opinion that it could be done

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25 April 1871.



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25 April 1871.

without harm to the collections. I believe all my colleagues gave an opinion the other way. It certainly would be a very expensive thing to do with the present structure, so as to make it safe and remove the products of combustion; but, nevertheless, it appeared to me that it would be perfectly feasible, and that it was merely a question for the engineer and the architect.

7475. (*Dr. Sharpey.*) Could provision be made for that in the new building, in case it was required?—I should think without any difficulty whatever. An architect who could not make it, I think should hardly be entrusted with such a responsible duty.

7476. (*Chairman.*) For how many hours should you like to have it open on Sunday afternoons?—I should say from two o'clock as long as it was light. It would be an expensive thing in some degree, because you certainly would have to add somewhat to your staff, and you would have to give more pay, or a proportionately larger holiday at other times. I do not think you would want more than that, some of the attendants would probably undertake the duties simply for additional pay. There would be a certain amount of option to be given them between those two things, but the addition to your staff would not be very great.

7477. Do you think that much may be done in the way of exchanges?—I have done a good deal myself in the way of exchanges, and it is a subject on which I would speak with a decided opinion myself, although I know that I am rather in the minority again on that point; but I do believe, myself, that the position that a keeper in a national museum holds is one so immensely advantageous as regards the acquisition of specimens, that it is a very desirable thing indeed that it should be utilized for the good of other museums, besides the national museum. In point of fact, many a very fine mineral I have rejected, and at this very moment there are minerals in my room that I am going to reject, because I have got minerals very nearly as fine, and I do not think it right to go to the expense of giving a great deal of money to buy still finer minerals, when I have got some that are so nearly equal to them. If, on the other hand, I were looked upon as a person who was, in a case of that kind, acting not only for my own department, but in a more or less direct way for other museums, I should have no hesitation in buying such specimens. I should then be able to say at once the museum in Dublin, or the museum in Edinburgh, or Manchester, or somewhere else, will be delighted to get what had till now been, perhaps, my first specimen, and I could write to them saying, "I have such and such a specimen come in, and I have such a specimen for which I gave so much at another time; will you take the original specimen, and enable me to buy this, or if I can get you such a specimen at such a price, will you take it?" or if, for instance, the governors of the museum were to say that I might purchase a thing of that kind with the hope of its ornamenting and benefiting some other museum, I should be able to add a finer mineral to my own cases, and at the same time be sure of benefiting another public museum too. And, on the other hand, I maintain that if duplicate specimens were sent out from the Museum to other museums carefully labelled, and with the authority of a department in the National Museum, they would carry with them to those other museums a value which they do not always carry when they are bought directly from a dealer. I could mention a case which I happen to know, in which very large purchases were made a few years ago, from a dealer of minerals, in London, of which I am perfectly confident that a considerable number have gone out with wrong labels, perhaps as to the nature of specimens, and certainly as to the localities of some of the specimens. Those are the kind of mistakes that would never occur with specimens of that kind issued by the British Museum, and, therefore, I think that, as regards my own department, I could certainly be of immense use to other museums, and

improve my own collection there, if I had considerable latitude accorded to me with respect to expenditure of the kind that I have been speaking of. I do not know whether we should consider them as exchanges or whether we should consider them as gifts, perhaps gifts are even better than exchanges when they are made by the Nation to National Museums, especially to such small local and colonial museums as the Government might be ready to support in that way. I am convinced that we might be, in this manner, not only benefiting ourselves, but that we should really rise into a National Museum in a sense that we are not at present, and I do not think we can be until we are *en rapport* in that or in some similar method, with other museums of the British world, including India.

7478. Would an arrangement of this kind involve much increase in cost?—It would involve some cost. In my own department it would give us a little more work. I should, perhaps, need one more assistant if it became a large and an important thing, but otherwise it would only give us a little more work, and it is a work which we would do very cheerfully, because it would be for the improvement of the collection. As far as the expense goes, of course, I should require considerable purchasing power, that is all. I have a very good fund allowed me at present for purchases, and I do not think it would require to be very much increased to enable my department to be of great use in the way proposed. Of course the grant could be increased to any extent, and the use of it in that way could be increased very largely indeed, but still I think it could be increased quite sufficiently largely to be felt by other museums to be of great use, without anything very perceptible in the estimates.

7479. But if the scheme answers I presume you do not consider that any large permanent increase of expense will be entailed?—Not any large permanent increase, but, of course, as I say, it could be increased very much. A case of this kind happens. Perhaps I receive from Cornwall, or from somewhere abroad, a large number of specimens to choose from, many of which are specimens of the same thing. I select from them those that I most want, and the rest I send back. But, if I were going to purchase the whole lot I could buy them much cheaper than I could buy a few, and in that way, undoubtedly, I could, by a not very considerable extension of my grant, acquire duplicates to such an extent as would enable me really to send almost collections instead of specimens to other museums. Of course one does not wish to carry the thing too far. In all these cases it requires judgment and prudence to assign limits to the extent to which you would carry a proposal of that kind.

7480. Are there any considerable number of local or provincial or Colonial museums that would be glad to enter into an arrangement of that kind with the British Museum?—I should think so. I do not know exactly, but I should think there would be several Colonial ones, and certainly four or five in Great Britain. Of course I have never broached the subject, because I have never had any authority to do so. I have made exchanges myself with foreign as well as colonial, and museums in England. I have made exchanges, for instance, with Madras and with Calcutta, and with other places (to a considerable extent in the way of meteorolites, for instance), and, in the way of minerals, I have sent out small collections of minerals carefully labelled in exchange for single important specimens. There have been various exchanges in a small way that I have done, and I have no doubt that if the thing once were recognised as a system, one could carry it out in a much larger and better manner.

7481. At present, are you frequently in communication with the keepers of mineralogical departments in other museums?—Very frequently, constantly in fact; they are, many of them, I may say, my personal friends.

7482. (*Sir J. Lubbock.*) You think, if I understand you rightly, that the British Museum might be



made very much more useful to science than it is at the present time?—I think it could, certainly.

7483. You do not consider that the mere movement to South Kensington *per se* would have that effect at all?—I think not at all. In fact, I have always viewed it in the contrary light. I have always considered the locality of South Kensington very much against us, but, at the same time, if we go there, the next thing is to consider how we can make the museum there most attractive to students.

7484. Without, of course, expressing any opinion as to the individuals, do you think the present system of Trustees a desirable form of government for a National Museum?—I have expressed my opinion upon that very decidedly before, in my evidence before the Committee of the House of Commons, and I still adhere to it. I do not think that so large a body as the Trustees, a body elected so little with a view to the scientific wants of the museum, is really a body which, if you had a *tabula rasa*, you would select for the Government. Of course, you must remember that things that are, have to be reasoned about rather differently from things that one would wish to be.

7485. I do not understand that you would wish to do away with the governing body of Trustees altogether, but rather that they should be fewer in number?—I own that I have a sort of idea myself that the system by which the Observatory at Greenwich is at present, I do not say kept in order, because it does not want keeping in order, but by which it is generally supervised, and regulations I believe made for it, namely, a Board of Visitors, seems to me an exceedingly good way of performing the sort of supervising duties that are required.

7486. The Board of Visitors at Greenwich go down to Greenwich once a year, do they not?—They only go once a year, but a Board of Visitors to the Museum might go every quarter, or every half year, or whenever they pleased, in fact.

7487. Do you think it would be a good plan to specify beforehand certain formal meetings?—I think these are questions of detail which would arise very much more when one had got the thing in full working. Sometimes you would want more frequent meetings, at other times you would want fewer meetings. I think that those are things that ought to be left in the hands of the Visitors themselves, or of the Minister to whom the Visitors would be responsible.

7488. Then it is not the frequency of the meetings, but a limitation in the number of the Trustees that you advocate?—The limitation of the number and of the authority. I want them to be rather a supervising than an administering body.

7489. Also I presume you would wish that, as in the case of the Visitors at Greenwich, they should be chosen for scientific attainments?—Certainly.

7490. You would think it probably desirable that the Presidents of the principal scientific societies which are concerned with biology should be *ex-officio* members of the body of Trustees or Visitors, or by whatever other name they might be called, at the British Museum?—Certainly I at one time thought all such personages should be *ex-officio* members of such a board. But if I may venture to speak of such august bodies with some freedom, I would say that I do not quite feel sure that the Presidents of those bodies are always elected entirely for their scientific attainments. I would instance, for example, the Zoological Society. I am not a member of the Zoological Society, but from what I have heard of it, I have been led to the opinion that they have not always elected a person to be President of the Zoological Society because he was an eminent scientific man.

7491. At any rate, that remark does not apply to the present President of that Society, who is an eminent ornithologist?—Certainly not, if that is, indeed, the case. The Linnean Society and the Royal Society certainly are not in the least amenable to such an observation, nor the Geological Society, which is always headed by a geologist, and certainly the Presidents of those societies I should think

eminently fit to be members of such a board. Originally I had the very same view which you suggest, but I had a little misgiving on the ground that I was afraid that it was not always the case that persons were placed in those chairs for their scientific attainments. If you could ensure that, or if there were a certainty that the majority of them would be so, I certainly think that they would form admirable persons for such a board.

7492. Do you know a case in which the President of the Linnean Society or the Geological Society has not been selected for scientific attainments?—No, I think quite the contrary.

7493. Then it would be quite exceptional, if they were not?—Yes, I think so. In selecting the societies, I should leave it to the Minister to select the societies, and he would be advised by persons of eminence in science as to which were really the proper societies to furnish persons who would be quite the men for such a position, but I presume that you do not mean to ask me whether I propose that such a board should consist exclusively of such gentlemen; for you would, I suppose, associate with them some other persons.

7494. Clearly not; the Presidents of the principal societies, of course, would be selected after due consideration, and they would form *ex-officio* a part of the governing body of the British Museum?—Yes; at present at the British Museum we have the President of the Royal Society, an *ex-officio* member of the board, and also the President of the College of Physicians.

7495. The Royal Society of course is the foremost of all our scientific societies, but at the same time the President of the Royal Society, being very often chosen for mathematical attainments, is, perhaps, less likely, is he not, to be in all cases so invariably a fit person to be a member of the governing body of the British Museum as the President of the Geological, or one of the other Biological Societies?—My answer to that would be on the contrary. Perhaps you are aware that I have proposed the possibility of my department being dis-severed from the biological portion of the British Museum, but if my department is to form part of the museum I should be extremely pleased to think that we had upon our board a mathematician, and a physicist, and a person who could appreciate crystallographic and morphological questions.

7496. You would think it desirable, would you not, that the more special biological societies should also be represented?—Yes, fully represented; but if mineralogy is to be a part of the new museum, I think that the President of the Chemical Society would certainly have quite as fair a claim to sit upon it as the President of any other society, mineralogy being practically a branch of chemistry.

7497. What would you consider to be a convenient number for the Board of Trustees or Visitors, as they might be called, of the British Museum?—I think I should limit them to the number of the muses. I think that nine would be a quite large enough body.

7498. Would you say five, representing the principal biological scientific societies, and the Royal Society, and that the other four or five would probably be best appointed by a responsible Minister of the Crown?—I think so, the five representing all the societies.

7499. And the appointment to places in the British Museum, if I understand you aright, you think should be made by the Minister on the recommendation of that body?—I think so; at the same time I should much wish that in such a body you should consider the position of the Keepers. I think that their position relative to that body is a matter which you should consider very carefully with regard to access to the board, and with regard to their presence at their meetings, and so on. One of the things I am pointing to is this, that practically speaking proposals regarding subordinate appointments in the departments ought to emanate from the keepers. In the case of a vacancy, I think the board should in the first place look for a recommendation to the keeper of a department; he would, practically, I presume, recommend

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25 April 1871.



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F.R.S.

25 April 1871.

a person or persons to the board that you have been speaking of, and they would have the responsibility of recommending that person directly to the minister; but the whole responsibility of appointment ought to rest with the minister. At present, it seems to me that we suffer from the difficulty that you are very likely to get into if we have too much intervention between the keeper and the minister; that is to say, the responsibility not really falling anywhere, but being divided among many. It is a very important thing that public scientific opinion should be brought to bear upon the persons who make an appointment of this kind, which, perhaps, the minister might be too great a man to feel, but which the keeper of a department would most distinctly feel; therefore, I think that your board of visitors, while keeping for use in special cases the right of intervention, should rather be considered as handing on the recommendations of the keepers with respect to appointments than as making distinct specific appointments of their own. In fact, an appointment of this kind should be considered as emanating from the keeper, and if an appointment is objected to by the governing body they would object to it on their own responsibility, and throw it back upon the keeper, as it were, they, in such a case, intervening between the keeper and what they conceive to be the interests of the museum, where they think that he is not sustaining those interests. One would consider that the keeper was the person who would know best what was wanted, and that the board would simply hand on his recommendation, only interfering with it when they felt that the recommendation was one which was not a proper one.

7500. You think that the keepers of the departments should have greater freedom of access to the governing body?—I do; emphatically so.

7501. Do you not consider that, subject to the control of Trustees, the whole museum should be under one Director?—In my opinion it is a matter of very little importance whether it is under a single director or not. I think, if you have a body of keepers, as I said before, and entrust the directorship to one of them, perhaps annually and in rotation, as has been proposed, I understand, by the Commission in another case, that would answer the purpose perfectly. On the other hand, if it is thought by people generally that a place of distinction like that is a place which should be filled permanently by a distinguished man, I should be the last person to say that it is not so. I do not myself feel that I care at all about it as a keeper. I feel that I could work equally well under either system. I do not believe very much in the great advantage of a Superintendent over the whole, because he cannot understand all the subjects.

7502. If you had one General Director, I presume that the recommendations of the keepers with reference to appointments would go to the Board of Trustees or the Visitors through that general director, would they not?—I presume that they would, and thereby you would interpose yet one more step in the ladder which I want to make as short as I can; you interpose one more point at which interference is engendered and responsibility becomes dissipated.

7503. Under these circumstances you would, therefore, have four such steps; would it not be better to leave the subordinate appointments in the museum to the body of Trustees or Visitors, reserving to the Minister of State the appointment perhaps of the Director and of the Visitors or Trustees themselves?—I just now spoke about two kinds of subordinate officers which I think it is very important that museums should have, namely, those who are temporarily, not permanently, employed on the staff, and those who are on the staff. I think that, perhaps, the question which you have raised might be really solved by appropriating the appointments of, we will say, temporary persons, to the keeper alone, and letting all other appointments vest in the body that you speak of, or vest in the Minister on their recommendation. I think that might do, but I have always felt great difficulty about this

question of appointments; the great thing is, I think, to throw the responsibility somewhere.

7504. You consider, do you not, that if the museum were open on Sunday afternoon, it would be very largely used?—I do.

7505. And you do not see any practical difficulty in that?—I see none whatever; it is merely a question of employing a few more persons, or, perhaps, even employing the police, which, of course, comes to the same thing; it means a certain amount of expense.

7506. You do not consider that those who would visit the museum on Sundays would be the least more likely to interfere with the specimens than any other persons?—No; rather the contrary, I should say.

7507. And you believe that their visiting the museum would have a good effect upon them?—Very good indeed.

7508. Are the museums abroad in many cases open on Sunday?—I am not myself personally very well acquainted with what the regulations abroad are, but in some cases, I think in Germany, some of the museums are only open on Sunday, and I understand that they are largely attended.

7509. Have you ever heard of any complaint in those places of the conduct of the visitors?—Nothing whatever.

7510. As to opening in the evening, do you not think that the fact of the museum not having been more largely visited in the evening was very likely in a great measure due to the fact of its being open not being as yet generally known?—It is possible, but, on the other hand, I think that after a week or two things of that kind do get known about the museum. I illustrate it in this way, that in Easter week and Whitsun week you often find that on the Tuesday, which is generally a private day, we have a very thin attendance because people have not learned that in those weeks the museum is open, but on the Thursday you will very often have a very good attendance, people having found out, in that short time, that the museum is open for the week, and, therefore, I do think that after it has been open a week or two in summer it ought to get much more widely known among the working classes of London than it seems to be. That has always puzzled me. I cannot understand the reason why the opening in the evening has been, I am sorry to say, a failure thus far.

7511. As artisans generally work until 6 o'clock, probably they would hardly have time to go home and change their dress and come to the museum before it was closed?—That very likely is the explanation of it, but on a Saturday that would not be an explanation, because they break off work earlier.

7512. (*Professor Smith.*) In what manner are the vacancies in the British Museum now filled up; I mean, when a vacancy takes place, is there public notice given of it?—I think there is very great deficiency of public notice. Generally speaking, there is a book kept by the Principal Librarian, and the persons who are candidates for appointments enter their names in this book, and from those names, which are also accompanied by testimonials in the hands of the Principal Librarian, persons are selected by the Principal Trustees, sometimes, I presume, on the recommendation of the Keepers, and sometimes, probably, on the recommendation of the Principal Librarian, but they are recommended to the Principal Trustees, and they drop from the clouds, as it were, into the Museum. One does not know on what grounds they have been elected, or on what grounds men have been rejected, but in that way the appointments are made. My own experience is, that if a keeper asks for a particular person, as a rule, he will get him. I have had in my department, I think, six appointments, and of those five were made by the Principal Trustees at my own suggestion, they having appointed the persons whom I recommended, and I attribute to that very much the quantity of work which I have been able to do in my department: I have always had good men in consequence.



7513. Are the higher offices in the Museum generally filled by promotion from the lower ones?—I believe I am almost a solitary exception in the Museum to that. When my department was created, I was brought in from without. Every other keeper, and every other assistant keeper in the Museum is, I believe, appointed from the subordinate situations of assistants.

7514. Do you believe that that system of filling up the higher appointments by promotion from the lower ones is calculated, in the long run, to secure the services of the best men for the Museum?—Under the present system I do not think it is. I think unless you have an opportunity of weeding out, as it were, the men who occupy the position of assistants, unless you can select your keepers from a select body of assistants, a body of very select men, I do not quite see how you are to secure for yourself the best men. In fact, it has always been some little astonishment to me that we have got the very good men that certainly many of our keepers are by the present method.

7515. As a matter of fact, do you find that the inferior appointments in the various departments of the British Museum attract as candidates men who have been educated at the public schools, or at the Universities, for instance?—I think not, certainly. The appointments are not good enough, the progress is too tedious, and the ultimate reward of even keepers is so very small in a pecuniary point of view, and I might also say in the consideration they enjoy, that I do not think that the method of appointment at present is at all calculated to ensure your getting the ablest men into those lower appointments.

7516. Are the candidates for those lower appointments examined by the Civil Service Commissioners?—Not quite always, but, except in one or two exceptional cases, they go before the Civil Service Commissioners and pass an examination.

The witness withdrew.

Sir PHILIP DE MALPAS GREY EGERTON, Bart., M.P., F.R.S., examined.

7519. (*Chairman.*) I believe you have been for many years a Trustee of the British Museum?—I was elected in May 1851.

7520. The removal of the Natural History collections to South Kensington may now be considered a settled matter, I presume?—It may be considered so, but I have never consented to the removal.

7521. But, as a matter of fact, I believe it is settled that they are to be removed to South Kensington?—As a matter of fact that was decided by a majority of one at a large general meeting of Trustees.

7522. Are the buildings in progress yet?—That I am not aware of.

7523. In the event, however, of the collections being removed to South Kensington, do you think it desirable that the present system of government of the museum should be maintained?—I have had a good deal of experience in my life in conducting business in different ways, and if I were to instance one institution which I thought the best, and where the business was better attended to and more carefully conducted than any other, I should instance the British Museum, with some few alterations and exceptions.

7524. Do you think that natural science is sufficiently represented on the Board of Trustees?—No, that I do not. At the same time, the general business of the Museum is conducted in the most admirable manner.

7525. Are you satisfied with the present system of making the appointments of the heads of departments?—The appointments are now made by the three Principal Trustees, but I must say that they have always shown every desire to put the best men in the place. The patronage must be exercised somewhere.

7526. And you cannot suggest any improvement in that respect?—I can suggest no improvement in that respect.

7517. But the examination is not competitive, is it?—No, it is not competitive. I believe in no case it is competitive. It depends upon what the appointment is. If a man is appointed to the lowest step on the ladder of assistantship, that is, if he is first made what is called a transcriber, he undergoes a simple examination, and when, again, he is appointed assistant, should he rise to that rank, I believe that he undergoes a second examination as assistant, but after that he undergoes no other. Of course, it is only what you call a pass examination—it is not a competitive or class examination at all. With regard to Professor Smith's question about the public school men and University men, I should say that they are quite an exception in the museum. With one or two distinguished exceptions, we have hardly a man known at the Universities at all, or public schoolboys either.

7518. Do you attribute that simply to the places not being good enough to attract them, or to any want of desire on the part of the authorities to secure the services of such men?—It would hardly be for me to attempt to answer that question, because I cannot assign any motive to my colleagues or other persons who recommend the appointments. All I can say is, that certainly we have not got that stamp of men, and I attribute that partly to the very small emolument and to the whole character of the appointments, and partly to the old story of the slow progress of promotion, and finally, no doubt, if you once get at the head of a department in an institution of that kind, men who themselves do not belong to the class you speak of, it is obviously only human nature that you should not have the introduction of men possessed of a higher kind of education than their own very much encouraged, and I do not think this higher education is as much appreciated or encouraged as it might be among us at the Museum.

7527. When the heads of departments have been appointed, would you permit them to exercise greater powers than they at present possess in their several departments?—My notion of a Natural History museum would be this, that there should be a Board similar to the Standing Committee of the British Museum, limited in number, not of men whose time is exclusively devoted to science, but of men who have a certain knowledge in science, and also experience in the transaction of business; that, under this board, there should be one head over the whole museum, and under him as many keepers as are necessary. The extent of the different branches of the natural sciences is so great now that great subdivisions might perhaps be necessary. For instance, you would find it difficult to get a first rate entomologist who would be able also to take charge of the mammalia, the aves, and so on; so that subdivisions must be made, according to circumstances; but there should be one head over the establishment, and that head should have a seat at the Board.

7528. Is there no such head at present?—Professor Owen is the head of the Natural History Department, but he has no seat at the Board.

7529. You think it would be an improvement that he should have a seat at the Board?—I think so, decidedly.

7530. You would not think it desirable that he should exercise much additional authority on his own responsibility without being compelled to apply to the Board?—I think that such a board as I have described would be almost indispensable for the working of the Museum, and also for the assistance that it would give to the Director or the head of the museum.

7531. Would you have this Board appointed in the same manner as the Trustees are now appointed?—I cannot conceive of a better board than a board appointed from the present Standing Committee; for instance, our Natural History Committee. We have a Sub-Committee of Natural History, and that would

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25 April 1871.

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25 April 1871.

make a very good board; it could sit at South Kensington, and transact the business of the museum there.

7532. How many does it consist of?—Nine.

7533. Are all of them acquainted with Natural History?—Yes. At the first meeting after the general meeting in May every year we appoint sub-committees, but we do not limit ourselves to members of the standing committee; we take either *ex-officio* Trustees, or family Trustees, or any trustee who happens to be adapted for the particular committee on which we place them, and we select those who have the best knowledge of natural history for that sub-committee.

7534. I think you said that you did not believe that natural science was sufficiently represented in the body of Trustees?—I think decidedly not.

7535. What remedy would you suggest for that deficiency?—I should suggest, as a remedy, that when vacancies occur some Trustee should be appointed of scientific eminence.

7536. How would you bring about the nomination of such scientific persons?—It was brought about first by the pressure of the Report of the Committee of the House of Commons, of which I was a member.

7537. Then they have been appointed since that time, have they?—Yes.

7538. Was it the practice to appoint none previously?—None previously. I think Dr. Buckland was the first appointed. The Committee sat in 1850. Mr. Hawes' Committee, I think it was.

7539. And you think that further steps in that direction are still required?—I think so. Sir Roderick Murchison is the only elected Trustee now who has any claim to be a scientific man.

7540. Should you recommend that a certain fixed number of persons acquainted with natural science should be appointed?—No; I should recommend that opportunities should not be lost of keeping up a certain scientific element in the Standing Committee. But it is not easy to find men of science who are at the same time men fit to discharge the business of the museum.

7541. And you would not recommend any decisive measures to be taken to add to the number. You would leave it to the Government of the day to act in that direction or not?—Just so; I should not recommend any decisive measures.

7542. With respect to the subordinate appointments in the natural history department, have the Natural History Committee any voice in the making of those appointments?—None whatever. The three Principal Trustees make all the appointments.

7543. Are you satisfied with that system?—No; I am not satisfied with the present system, because when the British Museum was put under the general Act, all the candidates for appointments were required to undergo examination, and to be under a certain age. We found the limit of age imposed prevented our getting men of sufficient experience for the discharge of the scientific duties for which they were to be appointed, and, consequently, we have had to apply for exceptions continually in that respect. Then, again, the board of examiners, not being composed of scientific men, is not competent to examine for those appointments; and, therefore, special examiners have to be appointed. Under those circumstances I think the present system is not a very good one.

7544. How does it work practically? Do you think that the subordinate appointments generally are satisfactory, and as good as could be made?—Yes, I must say that we have got a very excellent staff now.

7545. Are the recommendations of the heads of departments frequently attended to in the appointment of their subordinates?—Yes.

7546. And they are not discouraged from recommending persons on the occurrence of vacancies?—No, they are constantly consulted.

7547. (Sir J. Lubbock.) You have expressed a very favourable opinion as to the mode of the transaction of business by the Trustees of the British Museum. I think, if I understand you rightly, however, that was rather with reference to the mode of

conducting the business by the Trustees than as to the actual constitution of the body of Trustees themselves?

—My remark was with reference to the ordinary routine business of the museum which is brought before the Standing Committee. Formerly, as you are well aware, the whole body of Trustees attended just as they chose to the transaction of business, but after the alteration was made, and a Standing Committee of 15 was appointed, a great change came over the conduct of the business, and the Standing Committee, as a body, attend very regularly, so that the responsibility rests with the same parties always. Formerly there used to be, perhaps, a committee to-day, and there would be a different committee to-morrow, who would not know what was done by the previous committee; but now the attendance is very regular, and matters come under the same Trustees, so that they are quite up to the business that comes before them, and they transact it with very great care and very great attention. I remarked that there were some exceptions, and I alluded principally to the fact that the Standing Committee are not all powerful, but that the general meetings of the Trustees four times in the year overrule occasionally what is done by the Standing Committee, as in the case to which I have alluded with regard to the disruption of the Museum, in which case the *ex officio* Trustees were brought down and carried the measure by a majority of one. There were 9 for it and 8 against it. In the nine who voted for the removal of the natural history collection, there were only two who were on the Standing Committee; and of those who voted against the removal of the natural history there were six of the Standing Committee. The majority was made up by *ex officio* members who had many of them never attended before. Therefore, that is a case where I think the Standing Committee who attend to the business ought not to be overridden by the general body of Trustees who are not well acquainted with the business which has been transacted by the Standing Committee.

7548. The Standing Committee is elected, is it not, by the general body of Trustees?—Yes.

7549. And the general body of Trustees elect for the Standing Committee those of their body whom they consider to be best qualified to judge upon such questions as naturally come before the managing body of the Museum?—Just so. At the first general meeting in May the Standing Committee is appointed.

7550. And yet upon the most vital question which has been before the governing body of the British Museum for many years, the Standing Committee have been entirely set aside by a vote given against the large majority of that body by those gentlemen who very rarely attend to the business of the Museum?—Yes, that was so, and more strongly even than that. It was not merely the vote on that occasion, but the Standing Committee had for years before that been pressing upon the Government the question of retaining the collections together, and purchasing the land adjoining the Museum. I think, in the first special meeting which I attended in 1851, that question was brought before the Trustees, and they recommended the purchase of the land round the Museum. Correspondence went on for years, but the recommendations of the Standing Committee were always met by a positive refusal on the part of the Government, and it culminated in the vote to which I have alluded.

7551. In fact, the general policy of the Museum adopted year after year by those Trustees who were presumably best qualified to judge was set aside by a general meeting, of which the majority was composed almost entirely of *ex officio* members?—Just so.

7552. Can you imagine a worse system than that?—I mention that as an exception.

7553. In consequence of the great progress of science, and the great differentiation of the different branches of knowledge, it is almost impossible, is it not, for any one man to judge of the qualifications of candidates for appointments in the British Museum?—I think, as in all other cases, an opinion must be



formed by the antecedents of the person who is applying for the place, and by the recommendations of men of science who can be trusted.

7554. I presume that those recommendations and those antecedents ought to be very carefully gone into?—They are, and always have been, I think.

7555. By whom?—By the Standing Committee, and by the heads of departments. I may say this, that although the appointments are made by the three principal Trustees, we always make a point of talking the matter over in the Standing Committee, and consulting the heads of departments with reference to filling up vacancies, and we are enabled by that means to let it be known who we consider the persons best qualified for the appointments.

7556. The three principal Trustees, I think, are the Archbishop of Canterbury, the Speaker of the House Commons, and the Lord Chancellor. I need hardly ask you whether they are all gentlemen who have already an immense amount of duties of various kinds upon their hands?—Of course they have.

7557. Do they generally attend the meetings of the Trustees and the Standing Committees?—Both the present Speaker and the former Speaker attended very regularly when they could get away from their other duties. The late Archbishop attended very constantly, the present Archbishop I have not seen so often, his health has not been so good. The Lord Chancellor I never saw there in my life.

7558. Do you not think it would be better that those appointments should be made directly by the Standing Committee, because I understand they are practically made upon the recommendation of the Standing Committee?—If the Standing Committee chose to undertake the responsibility, I have no doubt they would do it very well, but as you are aware it is by Act of Parliament that the principal Trustees have the appointments.

7559. Do you not think it might be desirable that the Presidents of four or five of the principal biological societies should be *ex officio* members and Trustees of the British Museum?—No, I do not think so, and for this reason: most of the Presidents are appointed for two years only, they would attend for the two years, and then we should have a fresh man, and he would have to learn the work *de novo*. The President of the Royal Society is *ex officio* a Trustee, because that is considered a more permanent office.

7560. (Chairman.) Is the Standing Committee a fixed number?—Yes, 15.

7561. Do you consider that practically the government of the Museum is mainly in their hands?—Mainly; all the routine business.

7562. Would there be any serious objection to confining it to simply the 15 composing the Standing Committee?—No; I think there would be every advantage, and I should like to see it so.

7563. Striking off the general body of Trustees and the three principal Trustees?—No, I would not strike off the three principal Trustees, but the general body.

7564. But where would you leave the exclusive power?—I would have one general meeting for the visitation of the collections and for the appointment of the Standing Committee, and I would commit all the management of the Museum to that Standing Committee until the next general meeting of the succeeding year in the following May.

7565. (Sir J. Lubbock.) You objected just now to my suggestion that the Presidents of some few of the principal biological societies should be *ex officio* Trustees of the British Museum upon the ground that the presidents are continually changing; how do you think it would be if the council of some few of our principal societies were to nominate a Trustee. They would probably nominate the same representative for some years together, and he would be in almost all cases a gentleman who would be acquainted with that particular department of science?—I can scarcely give an opinion upon that without consideration.

7566. At any rate that would not be open to the objection which you stated before?—No.

7567. (Chairman.) Do I rightly understand you that the Standing Committee is elected annually?—Yes, annually.

7568. Does it usually consist of the same members?—No, we have generally a change. For instance, if a member of the Government happens to be on the Standing Committee and cannot attend, we replace him by another name, or in the case of any one who cannot attend regularly, we generally make a change.

7569. Do they practically elect themselves, or do the general body of Trustees elect them?—The general body of Trustees, and there is generally a large attendance at the election. The Standing Committee elect the Sub-Committees.

7570. You do not wish to see any change made in the way of electing the Standing Committee, but you would like to see it invested with larger powers?—Just so.

7571. (Sir J. Lubbock.) Mr. Maskelyne has given us some evidence in which he has expressed the opinion that it would be desirable to give the keepers greater power of dealing with duplicates; he thought that in that way many valuable specimens which are not actually required for the British Museum itself might be obtained for provincial museums, and that in the cases where he had already a good specimen, he might be able to hand it over to another museum, and to secure for yourselves a still better one. Have you considered that question much?—I do not altogether believe in duplicate specimens in anything. It takes at least an hour to ascertain a duplicate coin, and, with regard to fossil fish, I do not think I ever saw a real duplicate.

7572. But yet you would hardly propose to secure to the British Museum, and to arrange in a collection every specimen that was sent to it?—As to what are called duplicates, I should wish the British Museum to retain two in their own possession, and with any redundant specimens I think exchanges might be made, but I should be very sorry to see redundant specimens lent from the British Museum to local museums, inasmuch as we should appear before the country as drawing a much larger sum for our annual maintenance than we should employ, inasmuch as all redundant specimens are of value to us. As far as exchanges go, I think it would be a very good plan. We have carried out the plan largely, particularly amongst minerals, of exchanging redundant specimens for others.

7573. I only understood the suggestion to be with reference to exchanges, but, as far as exchanges go, do you think that this system which has been pursued in the Mineralogical Department might with advantage be developed in other parts of the museum?—It has been carried out in other departments.

7574. (Dr. Sharpey.) Are there not redundant specimens presented to the museum frequently?—In books there are.

7575. But of Natural History specimens, have you not sometimes collections sent from the colonies, and through the Admiralty from voyages of survey?—No; I should be very glad if the collections from all surveys were sent to the British Museum. There were some valuable things collected in the Survey of the Straits of Magellan that were sent elsewhere; but, with reference to redundant specimens of that description, they are very few. I am not authorised to speak from the Standing Committee, but we had a report not very long ago, not a month ago, with reference to what might be called redundant specimens in the different departments, and they are very trivial.

7576. Supposing that public departments were encouraged to send specimens obtained from Government Surveys and the like to the British Museum, as they would cost nothing, might they not be distributed to provincial museums with advantage; of course it would cost some trouble and some additional service in the museum?—It would require an increase of our

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25 April 1871



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25 April 1871.

staff, if we are to undertake the distribution of those specimens.

7577. It is a pity that they should be lost, is it not, or that they should not be made use of?—I think they might be made use of through other channels.

7578. Might not the British Museum become a great clearing house between the different museums in different parts of the country?—I should be very sorry to see it so. I think that anything which interferes with the regular scientific business of the museum is to be deprecated. I am quite sure that the distribution of specimens to any local museums who chose to come for them, or send applications for them, would take up a great deal of time and cause a great deal of annoyance, and would interfere very much with the business of the museum.

7579. My question applied entirely to specimens that were truly redundant and could not be made ser-

viceable in the museum?—Of course we should not part with anything that was not redundant.

7580. There has been a suggestion, has there not, for lending specimens?—I have answered that question before; that I object to it.

7581. I referred to specimens that are really superfluous?—As I said before any specimens that are really superfluous we exchange and get a *quid pro quo*.

7582. (*Chairman*.) Do applications from other museums frequently come before the Standing Committee?—We had an application, not very long ago, a general application, from General Sabine in the same direction, as to lending specimens, and in consequence of that the Standing Committee had the returns made to which I alluded, and I have no doubt that Mr. Jones could produce those returns if the Commission wish to have them.

The witness withdrew.

Adjourned to Friday at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Friday, 28th April 1871.

PRESENT:

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

PETER MARTIN DUNCAN, Esq., M.B. Lond., F.R.S., F.G.S., examined.

P. M. Duncan,  
Esq., M.B.  
Lond., F.R.S.,  
F.G.S.

25 April 1871.

7583. (*Chairman*.) I believe you are Professor of Geology and Palaeontology at King's College?—I am.

7584. Have you various classes of students attending your lectures?—I have.

7585. Will you be so good as to describe the different classes?—The most important class is that of the students of the Applied Science Department of King's College; students who are learning practical engineering, and geology forms part of their curriculum. The second class refers to the Modern Department. During the past year the Principal has been anxious that the gentlemen who are being taught under the modern department should know something of natural history and geology. Those gentlemen do not learn practical engineering; but they are educated in French, German, mathematics, and have an ordinary education, which does not comprehend a great amount of classics. The third class is formed of gentlemen, and clerks, and schoolmasters, and artisans, who come in the evening. Those gentlemen are not under the discipline of the College; they merely attend as occasional students. Those are the three classes.

7586. Have you separate courses of lectures for the three classes?—There is a separate course of lectures for the Applied Science Department, for the Modern Department, and for the Evening Class Department; three separate courses. For the first year, the men of the Applied Science Department attend the Modern Department lectures as a sort of extra matter of study.

7587. You have a certain number of persons attending your lectures who are called occasional students; are they distinct from any of those whom you have enumerated hitherto?—They are distinct.

7588. Can you furnish the Commission with the numbers of each of the classes which you have enumerated?—During the past year, ending Easter 1871, the number of students in the Applied Science Department who attended my lectures was 73; then the men who became first year students during the past year, by entering during the past year, attended certain lectures with the Modern Department, and of those there were 28. The Modern Department students number 20, the evening class 13, and the occasional students—that is to say, students some of whom attended in the Applied Science Department, and some

of them in the Modern Department—six. Five of the first year's applied science students attended the Modern Department twice over; and, therefore, the correct number is five less than I have mentioned in my *précis*, namely, 135.

7589. Can you furnish the Commission with the number of lectures delivered by you in the course of the year?—I gave 52 lectures during last year.

7590. How many lectures are attended by the students in the Applied Science Department?—Fifty in all, and a certain number of extra lectures which they attend with the Modern Department, making a total of about 70 lectures.

7591. Do any of the students in the applied science department go on attending lectures for more than one year?—They are obliged to attend them for two years, and, if they should remain a third year, they also attend during the third year, but that is rather rare.

7592. Of the 73 who were in attendance last year, were there a certain number of third year's men?—Some of them were third year's men.

7593. Do the students of the first year in the Applied Science Department also attend the lectures given to the Modern Department?—They do, with certain exceptions.

7594. Then we understand that every student in the Applied Science Department has to attend about 70 lectures during his stay in the College?—Yes, that is about the average.

7595. Will you be so good as to describe your first course of lectures, and of what it consists?—The first course of lectures consists in teaching what is usually termed physical geography, or physical geology; perhaps it should be more properly called the principles of geology. I begin at the beginning, and I give them the benefit of the new theories of evolution from nebulous matter, and teach them the theory of the earth, and, for reasons which, perhaps, I shall give evidence about presently, I give lectures during the last quarter of an hour of each attendance on some fossil invertebrate and its modern representative.

7596. What does your second course of lectures include?—The second course of lectures is more practical in its bearing; it includes stratigraphical geology



—descriptions of those strata which are more particularly wealthy in minerals, and special attention is paid to the formations in the colonies, especially Canada and Australia, which contain mines, or which can be explored for mineral purposes. The rocks of the formations are described, and the succession of animal forms in them also; and during the lectures I generally give a demonstration of a vertebrate fossil and its modern representative. In some parts of the course the relations which geology bears to practical mining is taught, especially with regard to coal and gold mining. Iron mining also is touched upon, and throughout the course some reference is made to the relations which soils and subsoils bear to the rocks beneath.

7597. Have you often occasion to refer to the operations of the geological survey?—I take the maps especially of the geological survey, and make my diagrams from them, and refer to them constantly. They are so exact that it is as well to refer to them instead of making ideal diagrams, and Professor Smyth's lectures I consider to be the groundwork of my mining lectures.

7598. What do you require from your students, besides attending at your lectures: do you require them to take notes?—I require them to take notes, and I examine their notes occasionally; but this is not a matter which has been very carefully looked after at present. That they do take notes I know from the results of their examinations, because the questions in examinations always require that representations of diagrams should be drawn by the students on some matters which they can only recollect through note taking.

7599. How frequently do the examinations take place?—Once in the year, at the close of the Easter session, so far as the Applied Science Department is concerned. The Modern Department has not yet had an examination. The evening class department passed through an examination at the end of the Lent term.

7600. Are the results of the examination made known to the students generally?—They are made known by the marks which are obtained by the students being placed before their names, and suspended, and they have prizes given to them, which are distributed.

7601. The lectures in the Modern Department are, I think I understand, quite recently established?—Yes, quite recently; only one course has been given.

7602. Are the students in that department much younger generally than the others?—About the same age as the others. I may state that every Saturday there is a lecture in the Modern Department except during holiday time, making about 28 to 30 lectures in a year.

7603. Do I understand that you gave that course of lectures previously to the first year's students of the Applied Science Department?—No, they were given together. The first year's students of the Applied Science Department attended the course which I gave to the Modern Department, in order to enable them to understand the lectures which I am now giving on stratigraphical geology.

7604. Was this course of lectures delivered before the Modern Department was introduced?—No.

7605. What did you do with the first year's students of applied science previously?—They attended my first course of 25 lectures on physical geology and the principles of geology. That would enable them to come up and to understand my second course, but those who enter during the year and who did not hear that course attended the Modern Department in order to come up to the second year's students of this year.

7606. What do you consider the principal objects of the course which you deliver to the Modern Department?—To enable the men to obtain some slight knowledge of natural history, and of geology and palæontology, so that when they leave the college they may be able to pursue one of those studies, and that they may be able to comprehend and argue upon the

great theories of life of the day. That was the view with which the Principal, Dr. Barry, and the Professor of Mathematics, Professor Drew, desired me to take this course. It was their desire that the men should be able to think out for themselves such important matters, and that they should not go out into the world and argue upon them, being absolutely ignorant of their foundation.

7607. Do you require this class of students also to take notes?—Yes.

7608. And have they also to undergo an examination?—They will undergo an examination.

7609. Are you able at present to form an idea how this course of lectures is succeeding?—The men appear to take a great deal of interest in the lectures.

7610. Is the attendance quite voluntary?—No, it is not; it is obligatory on all the students of the Modern Department and the first year's men of the Applied Science Department.

7611. Are there only 20 men in the Modern Department of King's College at present?—That is all.

7612. It is altogether a newly established department?—Quite so.

7613. How many lectures do you deliver to the evening classes?—18 lectures, and the last lecture was an examination.

7614. Are those classes attended to any extent by the regular students of the College?—No, they are not; they are attended by men who are supposed not to be able to attend the College during the daytime, and men who are not able to pay so much as they would have to pay if they attended in the daytime.

7615. Then they are intended for classes outside those for whom the College is primarily intended?—Quite so.

7616. They are not very numerously attended, I think?—No.

7617. With respect to the evening class of students, do you take any means of ascertaining how far they have benefited by your lectures?—The results of an examination are the only test.

7618. Is an examination on their part voluntary?—Quite so.

7619. I suppose men of 50, who I see sometimes attend your lectures, do not submit to an examination?—One of them went in for an examination; they are rather fond of it, I think, some of them. I think one gentleman must be 50 who attended, but I cannot speak decidedly upon that point.

7620. The result of those examinations is not published, I believe?—No, it is not; they have a prize given to them, and certificates of merit to those who have taken a certain number of marks.

7621. In the Calendar of King's College, at page 147, it is stated that there is a course of 10 lectures given to the Applied Science students of the first year during the Lent term, can you give any explanation respecting this course of lectures?—As those 10 lectures were to be of the same kind as those which I was about to deliver to the Modern Department, I thought it would save time and trouble if the first year's students of the Applied Science Department attended with the Modern Department, but that has nothing to do with the 25 lectures which the first year's men have to attend. Men who enter in any term during the year of our first year's men thoroughly understand that the course of lectures given in the Easter term would not be attended by men who entered in Michaelmas term; therefore, this course was made to meet that difficulty.

7622. Do you allow men to enter at any one of the terms?—Yes, at any one term.

7623. Have the results of the examinations generally been satisfactory?—The results of the Applied Science Department, I think, as a whole, have been very satisfactory, especially as far as the second year's students are concerned.

7624. Do any considerable number drop off after the first year, not taking sufficient interest in the subject?—They are obliged to attend; I rather think that their interest increases. Some few do not care

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anything about geology or anything else, but the great majority, I think, take a great interest in the subject.

7625. Have you any means of ascertaining whether those students, who are most successful, were well grounded in other subjects previously?—The best grounded men are always the most successful; they are the most attentive students, and they are the men who have passed the best examinations. Talking over the merits of students with my fellow professors enables me to discover this, and conversations with the students after the lecture also enable me to decide that their success depends upon their previous knowledge of mathematics, physics, and chemistry, and upon their ability to apply continuously. The third year's men usually possess greater powers of understanding geological reasoning than the second year's men.

7626. Do you think that the first year's students derive a certain amount of advantage from the lectures?—Yes, and several of them did very fairly; and one in particular, a man who did not appear to have paid more than usual attention to the lectures, passed a most creditable examination. On inquiry I found that he was expected to have done as much from his previous career in those sciences which relate more especially to geology.

7627. Is it possible for a student to be admitted to your first year's course of lectures without having obtained a certain amount of preliminary knowledge in mathematics, physics, and chemistry?—Hardly.

7628. According to the regulations of the College they must have obtained a certain amount of instruction in those branches of knowledge previously?—According to the regulations of the College they must have a certain knowledge of those subjects before they enter into this department. Then they are under instruction for one term before they come to me.

7629. Do you find that your students have any knowledge of the elements of astronomy and physical geography?—Hardly any indeed.

7630. Do they make less progress in consequence of the absence of knowledge in those subjects?—Certainly. They are so accessory, and refer so greatly to the foundation of geological science, that the more a man knows about them the more successful will he be and the more rapid will be his progress; but, as a rule, I find that the ignorance of the men on those subjects is really profound, especially with respect to natural history—they know nothing at all about it.

7631. Do you think it would be possible to require that they should have acquired a greater knowledge in those branches of learning before they attend your lectures?—I think it might be arranged that the first year's students should not attend my lectures at all, but that the geological education should be restricted to the men who are in their second and third years, and that the first year's men should attend lectures upon the preliminary subjects.

7632. Would you confine the geological lectures to one year?—I think so.

7633. And do you think that, at the end of that year, their progress would on the whole be more satisfactory than at present?—Certainly.

7634. That one year under those circumstances would be better than two years as at present?—I think so.

7635. Your students are composed, are they not, of a great variety of nationalities?—They are, especially in my class.

7636. What are the circumstances which have led to so many foreigners attending the geological lectures?—I am not aware of the nature of the nationalities of the occasional students. Those men to whom I refer are under the discipline of the College as regular students in the Applied Science Department; but I believe that the permission which is now given to men not to adhere so strictly to those old rules, which used to be in force when I was a student at King's College, and which necessitated men attending theological lectures and the chapel, has developed an element in the College which did not exist before; for

instance, a Russian, a young Spaniard, a Japanese, a South American, and men of that stamp and nature have certain immunities from attendance upon subjects which would prevent their being students had they to attend them.

7637. In consequence of the ignorance of your students in other branches of knowledge, is a portion of your time occupied in teaching subjects not strictly connected with your professorship?—It is.

7638. Do you find that absolutely necessary?—Yes, it is absolutely necessary. We could not get on in the least without it.

7639. Are you adequately supplied with the appliances necessary for your lectures?—I am very insufficiently supplied, both as regards specimens upon which to lecture and diagrams to use in lecturing.

7640. Is much additional time required for the preparation of your lectures in consequence of the absence of sufficient appliances?—Yes, a large amount of time.

7641. And is that caused by the want of funds?—The want of the funds of the College.

7642. Has King's College received any assistance in any shape from the Government?—No, it has not.

7643. Have applications ever been made for assistance of any kind?—I believe not. I am not aware of any,—but other institutions have had assistance.

7644. What institutions have had assistance?—I speak under correction, but I believe that the Museum of Practical Geology has granted specimens to different educational establishments.

7645. You are not able to specify any particular institutions?—No.

7646. Do you mean institutions in London or in the provinces?—In the United Kingdom.

7647. Have the Governors of King's College taken any measures with a view to remove the difficulties under which you suffer from the absence of proper appliances?—They have given me a small grant, but it is totally insufficient for the purpose, and a former Professor, Professor Ansted, supplied me with a very good series of diagrams, but which are still insufficient for my purpose, and the consequence is, that I really occasionally occupy a great deal of time in drawing diagrams myself, and occupy the time of the students occasionally when they have to be done rather elaborately upon the teaching board.

7648. Is your evening class course an additional source of trouble and difficulty to you?—It is so; the difficulty is to know what to teach the men; they are of all ages and of all classes of society. Some of them appear to be almost as well acquainted as the professor in some subjects, so that it is really very difficult to know what sort of course to give.

7649. Do any of the working classes attend those lectures?—No.

7650. Do you think that those lectures are of sufficient value to be continued?—I think not as they are now attended, but I think they might be made very valuable if an elementary course of lectures were to be given at a small price, and which might be open to artisans and to men of that stamp.

7651. Is the fee for those lectures beyond the means of artisans?—Yes, it is 1*l.* 1*s.* 6*d.* for 18 lectures.

7652. What was the object of the College in establishing that course of evening lectures?—The geological course of lectures was established several years ago when the evening class lectures were initiated at King's College, in order to enable men, who were not in a position to attend during the day time, to come, and who occupied the position of clerks, and men who were occupied during the day in trade and business. It was not intended, I think, to admit the working class, and in the early years I believe the classes were larger, but so many other institutions have taken up evening class work that now the classes are not so large.

7653. Then, in fact, do you consider that it gives you a good deal of trouble without any very adequate return for it?—I think that the results are very unsatisfactory.



7654. Does the College contemplate instituting a course of lectures for the working classes?—I do not think it does, but I do not speak advisedly. The whole matter of the evening class department is being debated upon by those professors who give instruction in the evening. There is every desire to continue the lectures, I think, but most of us would be glad to find the results more satisfactory.

7655. (*Professor Huxley.*) You appear to be of opinion that the Government institutions compete with King's College in instructing the working classes, and I should be glad, under those circumstances, to draw your attention to a passage in the evidence which has already been given to the Commission by Mr. Reeks, the Registrar of the Jermyn Street School, and to ask you how far this passage might qualify your opinion. In answer to question No. 560 he said, "We have had many applications from persons who are not artizans, and with the view of accommodating them other courses of lectures have been established at a slightly advanced fee, namely, 5s. for 10 lectures." I presume that those are the courses to which you refer?—Yes.

7656. Then I would beg your attention to the following passage in the evidence: "But I cannot say that they have been nearly so successful as the working men's lectures; the average attendance may be from 175 to 200." Then Mr. Samuelson put this question, "By the 5s. do you make more than you can do by the 6d.?" And his answer is, "Yes; but even 5s. would hardly pay for advertisements." I call your attention to that, because I think you will see from those facts that the competition is not a very serious one?—No, I think not, under those circumstances.

7657. (*Chairman.*) If the professors were not under the difficulties to which you have referred, do you think that the number of students would be materially increased?—My impression is that the number of students would be increased. I think that the style of teaching in the College would become more advanced.

7658. Do you think it would be desirable that the course should extend beyond the limits to which you are obliged to confine it at present?—Yes, that is my opinion.

7659. Do you mean that it should extend over a longer period, or that there should be a greater number of lectures during the year?—The students now attend, in the Applied Science Department, 25 lectures in the Easter term for two years. We will take that as the most important part of their work, and then there are 10 or 20 lectures which they attend with the Modern Department. I think that the first year's students would do better if they did not attend any other lectures, so far as I am concerned, except those on biology and physical geography. I think that the second year's men should attend lectures only twice a week in the Lent and Easter terms, and the first part of that course would comprehend the principles of geology, and the second part, stratigraphical geology. That would give a course of 40 lectures in one year, and they would attend twice a week instead of three times a week.

7660. On the whole, you consider that the College is much hampered from the want of sufficient means?—Greatly hampered, no doubt about it, and has been ever since I recollect it.

7661. Can you state to us what your receipts for last year were?—My receipts for the year ending the end of the Lent term, 1871, were, for the Applied Science Department, 72*l.* 16*s.*; for the Modern Department, 9*l.* 9*s.*; for the evening class, 10*l.*; and for the occasional students, 5*l.* 8*s.*; making 97*l.* 13*s.*; that is what I received from the College. The greater amount which the College receives, of course, I am not aware of; certain deductions are made, but this is what I received.

7662. That is the net amount which you received for the discharge of your duties as Professor of Geology?—Yes.

7663. And a very large amount of your time was nevertheless devoted to your duties?—A very large amount of my time.

7664. Do you think that the duties of the Professor of Geology ought to occupy all his time, with the exception of a small amount of it devoted to original research?—I think so in King's College.

7665. But, under existing circumstances, it is hardly to be expected that the Professor can devote his time in that way?—It is impossible.

7666. Is there any biological course at present at King's College?—Not in connexion with the Applied Science Department, or with the Modern Department.

7667. Do you consider it to be of importance that such a course should be established in connexion with the Applied Science Department?—I do. I think it is very important, as preliminary to the geological instruction. I think that the biological course should be given by the Professor of Geology and Palæontology, otherwise there might be a clash of opinions, which might be very fatal to the success of the instruction.

7668. Then you would not have a separate Professor of Biology?—I think not.

7669. You would be willing to deliver such a course of lectures, if you were provided with means?—Yes, certainly.

7670. Have you had other means of ascertaining to what extent a general desire for acquiring geological knowledge exists at the present day?—I have.

7671. Do you think that there is a very great wish among many persons to become well acquainted with geology?—I believe there is a very great wish on the part of all classes with whom I come in contact.

7672. You think that a large number of persons take an interest in the study?—A very large number.

7673. And do you think that many of those, who would otherwise be desirous to become well acquainted with geology, find a difficulty in obtaining that knowledge?—I think that great difficulty is found in obtaining knowledge, partly because some men do not think of it until they get on in life, and then when they begin to see the importance of the subject, or to interest themselves generally in it, they find that their preliminary education has been so deficient that they cannot comprehend geological facts, and the science has grown so largely now that a man almost despairs, soon after he enters upon the study, unless he has had a very fair previous education.

7674. You have been an Examiner in the University of London on geology, have you not?—Yes, I am one of the examiners in geology at the present time.

7675. Do many of those who go into the geological examination show great deficiency in knowledge of the subject?—The examination which I held last year for the second examination for the Bachelor of Science degree was attended by a certain number of candidates for the title, and a large proportion of them displayed, I think, extraordinary deficiency in correct geological knowledge; they gave proofs of having been very unsatisfactorily taught, or rather of not having been taught at all; they had picked up their knowledge where they could; considering what is required of a Bachelor of Science, I think that the amount of geology and palæontology which was shown to be possessed by those who went in upon the last occasion was most unsatisfactory. One student distinguished himself in palæontology and passed a very creditable examination indeed, and took honours, but certainly one-half of those who went in for the examination displayed a very unsatisfactory amount of knowledge.

7676. Have you formed any views as to the best means of remedying those defects?—I have thought carefully over the matter; and I think that the only difficulty is the pecuniary difficulty.

7677. Do you mean as far as King's College is concerned?—Yes, and I think other establishments

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also—the same remark would apply to University College.

7678. If the Professors of Geology at King's College and at University College were better rewarded for their work, have you reason to believe that the results of their instruction would be more satisfactory?—I have no doubt about it. The lectures could be prepared with greater care, and certain increments of error which will creep into lecturing, would be prevented by the professor having more time to devote to the preparation of his lectures. The men who could devote their whole time to geology and palæontology, would assuredly teach better than those who have to depend upon other matters for their livelihood as well.

7679. Could instruction in geology, in your opinion, ever be self-supporting?—I do not think it could.

7680. Do you see any probability of King's College being able, from its own resources, to endow the professorship more satisfactorily?—No; so far from that, the probabilities are that every year the professors will have to give a greater per-centage of their earnings to the College.

7681. Have you any suggestion to make as to how the difficulty is to be met?—The difficulty is to be met by a moderate endowment being granted by the Government; due precautions being taken on the part of the Government that the duties should be efficiently and properly carried out, and that certain classes, who are not now admitted to the College, should receive gratuitous instruction there. I would suggest, inasmuch as the Professor of Geology must usually be a man of middle age, that he should either have a retiring pension at a certain age, or else, which would be much better, that he should be allowed to retain the fees, and that any endowment should bear no reference to the fees. The retention of the fees would stimulate a man to work, and they would produce a sum equivalent to a retiring pension, and, under those circumstances, I would not recommend a retiring pension.

7682. But, at present, if the professor retained the whole of the fees his remuneration would be very inadequate?—Very indeed; it is no remuneration at all to me, for it imposes a loss.

7683. Even though you retained the proportion that goes to the College it would be inadequate?—Yes. Supposing a professorship were endowed, and that all the difficulties respecting the lectures and appliances were removed, I believe that you would have a much larger class there, and, therefore, the professor would obtain more fees, and that there would be a fund varying from 120*l.* to 150*l.* a year for a man to put by during the number of years which he held his professorship, in order to provide for his old age.

7684. The same considerations that you have been referring to would be applicable, would they not, to other professorships besides that of geology?—Yes, certainly. For instance, at King's College, the Professor of Physics has four times the work that I do, but I am not aware what he gets.

7685. Do you think that he is better paid?—I should think not. Of course, in amount, he receives more, but as regards better pay I do not think that he is any better paid than I am.

7686. Have you considered whether any general principle could be laid down for the conditions under which the Government should grant assistance of this kind; to what institutions would you limit it?—I should not limit it. Any institution that could prove that it was doing a certain amount of good work; any institution which had a certain number of students and had a reasonable curriculum; any institution which could show that it had already produced good results (there are not many of them in the kingdom); in fact all such schools which have no endowments and which we can believe in reason have no prospects of any, and which are languishing for want of support, I think ought to be endowed.

7687. Do you think that British science generally

suffers from the want of such endowments?—I have no doubt about it.

7688. And that the establishment of such endowments would lead to a considerable advancement of science in Great Britain?—That is my impression.

7689. (*Professor Huxley.*) With reference to combining the duties of the Professor of Biology with those of the Professor of Geology, did I rightly understand you to say that you felt that to be desirable? Supposing other things were equal, and supposing a college to be created, and that you could make your own conditions of payment and everything else, would you think it really wise to put such an enormous amount of labour upon one pair of shoulders?—No, I quite think that, as an abstract proposition, the chair of geology ought to be separated from that of biology as a matter of course, but from the peculiar position which King's College holds, and from the difficulty which there might be in establishing a separate professorship, I think it would be advisable there to combine the two, especially as there might be a difficulty in getting the two professors to teach the same views, and if the same views were not taught there would be sad difficulty between the palæontologists and the comparative anatomists.

7690. But I presume that your recommendation is only with reference to the peculiar condition of King's College?—Quite so.

7691. (*Professor Smith.*) Is there not at present any course of biology forming a part of the regular curriculum in King's College?—Not in connexion with the Applied Science Department or with the Modern Department, only with the medical. At the same time comparative anatomy, botany, and physiology are taught to the evening class department.

7692. But not in the Applied Science Department or the Modern Department?—No; but all students desiring to attend those lectures can attend them as occasional students, but they have not the time.

7693. Does King's College receive any endowment from the Government at present?—None whatever.

7694. (*Dr. Sharpey.*) In the preliminary study of biology to which you have referred as essential, or, at any rate, desirable for the students of geology, I presume you would include comparative anatomy?—Most certainly.

7695. With reference especially to palæontology?—Certainly.

7696. With regard to the granting of aid, do you think that it might be made a condition in granting aid that an institution should have resources also supplied by private means; to show, in fact, that those who had established it had been in earnest, and that there should be some evidence of private exertion in collecting funds for education, before the State was called upon to grant aid from the public money?—Certainly, I think that, when the private endeavour fails, then the Government ought to step in if the cause were worth furthering.

7697. Do you think that as a result of giving the professor a better remuneration, more time might be employed in the extension of practical instruction in the different subjects?—I think so certainly.

7698. That is precisely what would be gained by giving the professor more time at his disposal?—Yes, that would be really the case.

7699. Could you say what is the future career of your students generally; do they enter into the public service, and become miners or engineers?—The applied science students, the great majority of them, become practical engineers, and railway engineers, or they go into the offices of large surveyors. I believe that the best men get work immediately, and have no difficulty in obtaining it. Some of them go into civil engineering and some into practical engineering. I am not aware whether any of them are going into mining.

7700. Have any students followed the courses in your department with a view to becoming teachers of science in schools?—Not that I am aware of, but they may do so without my knowing it,



7701. (*Chairman.*) If the Government were to determine, as they might do wisely, according to your opinion, to give a certain amount of assistance to such institutions as King's College, you are of opinion, are you not, that there would be no very great demand upon the public purse?—I think not to any great extent—not if the Government went upon that principle of requiring proofs of good work having been done, and the possibility of more being done if money were granted.

7702. At what age do you think that a student can profitably apply himself to geology?—I think, taking what I know of the ordinary run of the education of students and their ordinary capacity, a student ought not to begin to learn geology until he is in his 19th year.

7703. Then you would not consider it a subject to be introduced at schools?—I think that what is called physical geography, or more properly physical geology, should be introduced at schools, but not geology proper.

7704. (*Professor Smith.*) With reference to any endowment that might be granted by the Government, have you formed any idea as to the control under which the administration of such endowment should be placed?—That is a matter which I have thought over, and I see that it might lead to great difficulties. The Government might wish to nominate a Professor of King's College, and such a professor might be objectionable to the Council of King's College, and I think it would be more satisfactory to scientific men if all those appointments were placed under the care of a board of scientific men of position, and who would be responsible to the Government for their nominations, and for the duties of the professors being well carried out. There would be no difficulty in obtaining such a board, because the presidents and officers of the learned societies, which have charters, would make a sufficiently good board, and a board beyond doubt as regards their scientific acquirements and their desire to uphold science. To leave the matter entirely in the hands of the Government would, perhaps, not lead to very satisfactory results.

7705. (*Professor Huxley.*) One question arises out of that. You have mentioned in your *Précis*, in more than one instance, I think, the existence of theological freedom at King's College, but still it remains a matter of fact, does it not, that the professors must be members of the Church of England?—Yes.

7706. And that might interfere very much, might it not, with either the Government, or such a board as

you suggest, making a particular appointment which they thought best?—Quite so.

7707. That is rather a serious objection, is it not, to bringing in the principle of endowment there?—Quite so.

7708. I believe it remains a fact that, notwithstanding all the liberalisation of King's College, the professors must be members of the Church of England?—Yes.

7709. (*Dr. Sharpey.*) With reference to such a board as you speak of, for administering any Government patronage that might be required, do you not think that, instead of assigning that duty to the presidents and officers of scientific societies, it might be preferable for the councils of those societies to nominate a member of such board, who might continue in it for a limited time, and who would be selected by them on account of his fitness for such a duty, rather than to let it fall on *ex-officio* persons?—Perhaps that would be better.

7710. As, for example, in the case of the governing bodies just now being constituted for the public schools, the Royal Society has been asked to nominate members of those bodies, and of course the council would select according to the person's special fitness?—Quite so; I think that would be quite as good as the other plan. With regard to Professor Huxley's idea of King's College being a Church of England establishment, the theological curriculum being now very much more liberal than it used to be, and University College, I believe, being not denominational, and the University of Edinburgh being Presbyterian, I think you would find that there would be a sufficient number of men holding those different opinions in geology to choose professors from, whenever there was a vacancy, so as not to interfere with the standing of the College.

7711. Do you know that the professorships in Edinburgh are not restricted to persons belonging to any particular church?—I was not aware of that.

7712. They merely sign a declaration on being appointed, to the effect that they will not use their professorial position to injuriously affect the Established Church of Scotland?—That is rather a strong thing to sign. The Principal gave up one of the hours which he used to devote to the instruction of students in Divinity, in order that I might give the lectures I have mentioned to the Modern Department, so that shows that the tendency, at any rate, of the present officers of King's College is to assist natural science, reasonably taught, as much as possible. I am not tied down in any way in my teaching, except by my own conscience.

7713. (*Chairman.*) Is there anything further that you would wish to state to the Commission?—No, I am not aware of anything further.

The witness withdrew.

WILLIAM CARRUTHERS, Esq., examined.

7714. (*Chairman.*) I believe you are the Keeper of the Botanical department at the British Museum?—I am.

7715. There are large national collections in botany both at the British Museum and at Kew. Can you explain to the Commission whether there is any connexion between the two collections?—There is no connexion between them.

7716. Do you think it is desirable that any connexion should be established between the two collections?—I do not see, upon the face of it, any reason for any connexion being established between the two collections.

7717. Do you think that the nation derives an advantage from possessing those two collections independent of one another?—I believe the nation does. But it is my impression that, inasmuch as we have collections in different parts of the country, in Edinburgh and in Dublin, kept up at the national expense, it is necessary in such a large centre of population as London, and much more as London is the attraction for science throughout the whole country, we should have national collections there, so that I would not put the necessity for a collection existing in London,

apart from the necessity of a collection at Kew, on the requirements of the nation so much as on the requirements of the enormous population of London, and of the scientific visitors who are in the habit of visiting London.

7718. Do you consider that the two collections have different objects?—I consider that Dr. Hooker, if you will allow me to refer to his statement, has put it very clearly in a document which I thought might be of use in connexion with this matter, namely, a Return to the House of Commons, "Of all communications made by the Officers and Architect of the British Museum to the Trustees respecting the want of space," and so on, ordered by the House of Commons, on the 11th of March 1859. At page 4, Dr. Hooker says: "There are two circumstances which I think the Trustees should bear in mind in dealing with the question of the transference of the botanical collections from the British Museum to Kew. 1. That it is in one sense immaterial to us at Kew what becomes of the British Museum herbarium; for a first-rate herbarium and library must be maintained at Kew, and are indeed essential to Kew for naming

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28 April 1871.

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"the plants in the Gardens and Museums of Economic Botany, and for giving to botanists and gardeners the information daily demanded of us." That is Dr. Hooker's own statement of the first necessities for the herbarium at Kew. In the British Museum we do not contemplate any object of that kind at all. It is a purely systematic and scientific collection of plants for the use of systematic botanists. In the second place, Dr. Hooker says: "That their being indispensable to Kew, and in constant use for the garden purposes, is no obstacle to their being consulted to any extent by other botanists, nor does it at all interfere with the facility of consultation. A herbarium and library of such value and extent as that at Kew must be, though originally maintained expressly for the use of the garden, cannot with propriety be closed to scientific botanists." I think that Dr. Hooker clearly separates the principal object of the British Museum herbarium, from that of the herbarium at Kew.

7719. Do a large number of persons make use of the collections at the British Museum for the purposes of study?—I made a note of the number of visitors. I may say that previous to 1867, no record was kept of the number of visitors. In the beginning of April of that year, by the instruction of the Trustees, a regular record was begun, and has been ever since kept. In the nine months of 1867, the collections were visited by 811 persons for scientific information; in 1868, 840 visited it; in 1869, 974; in 1870, 1,041; and during the first three months of this year the number of visitors has risen to 406, which is a much larger proportion than we have known on previous occasions, being at the rate of 1,600 a year.

7720. Are the collections so arranged as to be easily available to students?—The herbarium consists of two portions: first the systematically arranged herbarium, which is by far the largest portion of the whole; indeed, it contains, I may say, the collection, and that is carefully and systematically arranged, and accessible with the greatest facility; and the remainder of the collection consists of the plants that we are continually receiving either by donation or by purchase, or plants that have been similarly received in former times which have not yet been laid into the general herbarium. The great bulk, I may say nineteen-twentieths of the collection, is carefully arranged, and any one plant can be obtained in a few minutes.

7721. Besides those who go to the museum for the purposes of systematic study, are the collections visited by large numbers of the public merely from curiosity?—The numbers that I have given just now are the numbers of students—by students I mean not only men who come to investigate plants systematically, but also men who come for information which can only be obtained by application to the officers in the private studies of the museum.

7722. You are speaking of students who come on the days when the museum is not open to the public?—The herbarium is never opened to the public. There are two rooms open to the public, but of the numbers who visit those we have no record, as they are perfectly free, and the public pass freely through them without any special record being made of their numbers. The herbarium is separated from the public rooms, and before access can be obtained to the herbarium the bell must be rung, and special application must be made. I have only here a record of those who have come for botanical information, not personal friends who have called upon the officers.

7723. Have you the power of admitting anyone who wishes to examine the collection in the herbarium?—I have that power.

7724. Without reference to any other superior officer?—Yes.

7725. Is the staff employed in your department considerable in number?—The full staff, as it existed on the occasion of the retirement of Mr. Bennett, is a keeper and two assistants.

7726. The assistants are under your direction, I presume?—They are. At present there is a vacancy, so that there is only one assistant, but I hope that the vacancy will be speedily filled up.

7727. By the regulations of the museum, have you any voice in the appointment of your assistants?—I have been consulted. I may say that I have only been a few months an officer, and I have been consulted with regard to the appointment of the assistant, and I know that my own appointment was obtained directly through the recommendation of Mr. Bennett, the then keeper, and that the appointment of my colleague, Dr. Trimen, was similarly obtained.

7728. (*Professor Huxley*.) Do not you think it might be a material advantage to the country in general, as well as a saving of expenditure, if the herbaria at Kew and the herbaria at the British Museum were put in some sort of relation; that either should stock the other with what materials are superfluous in itself: for example, as Kew must often obtain a very large number of duplicate specimens of plants, would not it be desirable that such specimens as you might wish to have should come from Kew to the British Museum and *vice versa*?—I believe that it might be an advantage to us at the British Museum to have such specimens as were *desiderata*, but in the case of additions to the British Museum it has been the practice carefully followed by all the officers there never to acquire duplicates, to obtain only sets of plants, so that the number of duplicates that we have in the collection there is extremely few, and all of them are most unimportant.

7729. Are there not in the British Museum, collections which have never been thoroughly worked out and named. Mr. Brown's collection for example?—Mr. Brown's collections are not in the British Museum. The series of plants collected by Mr. Brown, and which were presented by him to Sir Joseph Banks, are all named and accessible in the museum, but Mr. Brown's own herbarium is not public property.

7730. I am aware of that, but is it not in some way in the British Museum?—It is at present accommodated there, but it has no connexion whatever with the museum. It is accommodated in a store room in the museum, but it is not the property in any sense of the British Museum.

7731. Whose property is it?—It is the property of Mr. Bennett.

7732. It is simply accommodated there?—It is simply accommodated there, in the same way as any book of mine, in my room in the Museum, may be accommodated there.

7733. Are there no collections which have not yet been worked out and examined in the British Museum?—I have explained that we have a considerable store of plants, which, of course, are being continually worked up, as there must be in all collections, but those plants are all arranged geographically and a large proportion are also arranged with regard to the great natural orders systematically, so that while they are in store they are all accessible to students and are continually being brought out for the benefit of workers, whenever they think that they are of any use.

7734. As a matter of fact, the collection at Kew is the only great scientific herbarium at present, is it not; I mean that the extent of accommodation and working is far greater than anything that you have at the British Museum?—I do not think so. I believe that the herbarium at Kew is more extensive and contains a larger number of plants, but for thorough systematic work, for the existence of a large number of authentic species and specimens that have been actually described, I believe that our British Museum herbarium is unequalled in the world; and that is not only the opinion which I myself have formed, for I am not very extensively acquainted with herbaria abroad, but it is the universal testimony of men who have become sufficiently acquainted with the British Museum herbarium to form an opinion worth considering.



7735. Is it not the fact, that foreign botanists, coming to this country, usually go to Kew for the purpose of working in botanical matters?—I believe that the British Museum is visited by all the foreign botanists that come to this country, and I may say that I ran over, a few days ago, the visitors that we have had during this year, just to form a rough idea of who they were, and I find amongst the foreign botanists, who have been in the habit of visiting the museum, the names of Cosson, Baillon, Triana, and Welwitsch, who have been here during the year 1871.

7736. But do those gentlemen come for the purposes of actually working at the collections?—I should say that Cosson has paid probably 30 visits to the museum, day after day, going systematically through a part of them.

7737. Would you recommend that the Government of the country should go on as it appears to be doing at present, keeping up two first rate herbaria, the one at Kew, and the one at the British Museum?—I should like to submit to the Commission statements made by men who are better able to judge of that than myself. In the first place, Mr. Robert Brown was distinctly of that opinion, and expressed it very strongly on several occasions. Mr. Bentham, the President of the Linnæan Society, also expressed very strongly the same opinion in the paper out of which I made an extract from Dr. Hooker's statement in the earlier part of my examination.

7738. Did not Mr. Bentham subsequently modify that opinion in a paper which he published in "Nature"?—I am not aware of any paper published by Mr. Bentham, in "Nature." It was not stated to be by Mr. Bentham.

7739-40. It has been stated before the Commission that it was by him, and in that paper I think he expressed a rather different opinion?—I will come to that presently if you will allow me. Mr. Bentham, in the evidence in 1859, to which I have referred, states distinctly that the removal of the botanical collections to Kew, would not be advantageous to science, and he also says, "I think the Sloanean is of more value at the British Museum than it would be at Kew, and I think that a great portion of the additions to the Banksian Herbarium since Sir Joseph's death are duplicates of those already at Kew." He further says, that it would be desirable to have a herbarium in London. Professor Henfrey at the same time insisted that it was important to keep a botanical collection in London. Dr. Falconer, who had the charge of both the Gardens and Herbarium at Calcutta, distinctly stated, as Dr. Hooker had already done, the necessity for a herbarium in connexion with the botanical gardens; but he also said, "I believe that a separate public herbarium and library in the centre of London and easily accessible are so useful and necessary that it would be in the highest degree inexpedient to do away with them." Sir Charles Lyell was strongly opposed to the removal, and Mr. Darwin thought that a National collection ought to be in London, but he could see that some weighty arguments might be advanced for Kew. As the result of that investigation, the Committee came to the following conclusion, which you will find at page 11, "Sir William Hooker, Dr. J. Hooker, and Dr. Lindley have given reasons in favour of the removal of the collections from the British Museum to Kew with the view of rendering that establishment more complete, but Dr. H. Falconer, long at the head of the Botanical Garden of Calcutta, and Professor Henfrey support the opinion of the late eminent botanist Mr. Robert Brown, and believe that such a removal would be of great dis-service to science, by depriving the consulting botanist of ready access to a central metropolitan herbarium and library. In this view Mr. Bentham coincides, with this exception, that he wishes the herbarium bequeathed by Sir Joseph Banks to be removed to Kew. In reference to the scientific importance of the botanical collection, in its illustration of the geo-

logical specimens in the museum, the opinion of Sir Charles Lyell is decidedly in favour of retaining such a botanical collection in the metropolis." For what reason I cannot tell, but a few months after that a memorial was prepared, which intimated a complete change in the opinion of several of those men. As this memorial was headed by one of the Commissioners present at this table, probably he may know something about it; but Mr. Bentham, in this memorial, completely upset the opinion which he had given two or three months before, an opinion which was in accordance with the opinions entertained by Mr. Robert Brown, by my predecessor, Mr. Bennett, and by many other distinguished botanists.

[Professor Huxley. No proposition has been made before this Commission to remove the herbarium from the British Museum, but the question which has been brought before us is the possibility, or the desirableness of bringing the two herbaria to some sort of relation to one another, so that the Government should not be actually doing two things twice over, seven or eight miles apart.]

Then, with regard to this particular statement which is published in "Nature," the same views were already expressed in an official document which was presented two years ago to the Trustees of the British Museum from the Board of Works, and this statement is nearly a reproduction, in slightly altered language, of that document, which was fully dealt with and answered, and this answer was sent to the Board of Works, and it was then understood as being perfectly satisfactory, both to the Trustees and to the Board of Works. I do not think it would be very difficult for me to show how utterly hopeless the study of botany, and especially palæontology, would be, if the London Herbarium were put in the position that is mentioned by Mr. Bentham.

7741. Will you be kind enough to tell us what is the date of the document in which the answer is contained, so that we may be able to procure it?—I do not know that the document has been published—it was an official document.

7742. (Chairman.) Was it not laid before Parliament?—No. I find that the date of the official document is December 1868.

7743. (Professor Huxley.) Is it your opinion that the two herbaria should be equally perfect and equally complete, without any relation the one to the other?—It is my opinion that it is absolutely necessary for the gardens at Kew to have a herbarium for naming the plants, as Dr. Hooker clearly puts it. It is also my distinct conviction that a herbarium for the study of systematic botany has no connexion whatever with a botanical garden. It ought to be in a position where it can be most freely consulted by all students of botanical science, and there is sufficient evidence that London is the best situation for such a herbarium.

7744. What is, in your judgment, sufficient evidence that it is better than Kew?—The number of visitors that are in the habit of coming to the department, and the kind of visitors that come. I made some notes from the same list from which I gave the names of the foreign botanists to show the kind of visitors that come for the scientific purposes to the British Museum. There are two clergymen who are on official duty in London who are somewhat eminent in botany; one is, perhaps, one of the most distinguished of British lichenologists, who would not be able to visit the collection if he were required to go to Kew to do so. We have also had visits during this time from two medical men who are in active practice in London, who are able to run in only for a short time on occasions, and who visit us for some special purpose to settle some precise point, in the one of these instances with regard to some species of moss, and in the other with regard to some fossil plants. Then I have the names of six men who are either in business or engaged in professional work in London, whose time is of great importance, and who could not possibly have gone to a great distance to consult a collection. There are two men

W. Carruthers,  
Esq.

28 April 1871.



W. Carruthers,  
Esq.  
28 April 1871.

who have come from the country to London on business, and who find it convenient to come to the museum to consult the collections, but who could not have gone during their short visit to London to any distance. There are other men living in London who are able to come and settle points on a short notice, which they could not do if they had to spend a day in seeking for the information. On that account I should consider that it was more convenient to have it in London. And then I find Mr. Waterhouse, who is a Keeper in the Museum, in evidence given in June 1860, makes the following remarkable statements with regard to the convenience of London as the site for a herbarium. He made this statement, which has not been contradicted, and I believe I know the parties referred to, and can confirm the statement if that were needed:—"One of our active botanists who was living at Hammersmith, and was consequently within a short distance of Kew, stated that it was much more convenient for him to come to London to examine the collections than to go to Kew. His explanation was this: that he constantly had occasion to come to London for other purposes, and he then took advantage of his visit to clear up his doubts upon botanical questions, whereas he was seldom led out in the direction of Kew. I have to-day heard of another person living at Turnham Green, also a botanist, who has said that it was more convenient to him to consult the herbarium in London than at Kew."

7745. Then the tendency of your evidence would be rather to stop accumulation at the general herbarium at Kew and increase the accumulation in London?—That is my judgment. I conceive that they must have a herbarium at Kew for the purposes of the garden, but that the great scientific herbarium ought to be where it is most easily consulted, and that is in London. That there is no connexion whatever between a herbarium and living plants in a garden, is clearly evidenced to by Mr. Bentham, who was asked in the document to which I have referred, at page 7, "Are you not cited in Lindley's 'Vegetable Kingdom' as an authority for the fact that in the year 1845 there were about 6,500 species of that family" (that is the *Leguminosæ*) "then known?—(A.) I believe I am so quoted by Dr. Lindley. (Q.) If so, can you state in a general way how many of these 6,500 species you became acquainted with only through the medium of herbaria?—(A.) I became acquainted with nearly the whole *Leguminosæ* through the medium of herbaria. There are not many hundreds that I have seen living. (Q.) What proportion of these 6,500 species may you have seen in the living state in botanical gardens; one-half, one-third, one-fourth, one-fifth, one-eighth?—(A.) I have examined very few in botanical gardens; very few indeed. (Q.) In your researches on systematic botany, have you been indebted most to herbaria or botanical gardens?—(A.) I have published several thousand new species of plants; I have never published one without examining it in a herbarium, and I have examined very few in botanical gardens." So that for the purposes of the systematic botanist, the value of botanical gardens, on the testimony of Mr. Bentham, is almost nothing. The one consideration, as it seems to me, is to obtain a large and most complete herbarium, thoroughly arranged, and in the most convenient place, and the testimony, so far as I know, invariably is, that the most convenient place is London.

7746. Have you at the museum now as good a botanical library as there is at Kew?—We have an infinitely better botanical library, inasmuch as we have the whole library of the British Museum.

7747. Is it infinitely better for botanical purposes than the library at Kew?—Infinitely better, inasmuch as for botanical purposes you require not only works specially devoted to botany, but you require Transactions and Publications where botany is sometimes included; you require books of travels, where occasional references are made to botany; and you require

series of works which it is next to impossible to collect together in any library, especially in one formed for work in one department of science.

7748. Is it not a fact that the library at Kew contains the Transactions of all those learned societies which give space to botany?—Not so extensively as the library of the British Museum. I may say, as a matter of fact, that the men who are in the habit of working at Kew frequently bring references to books which they cannot obtain at Kew for me to obtain for them in the British Museum library.

7749. (Professor Smith.) Is there at present any plan in which the naming of the two herbaria at the British Museum and at Kew is made comparative with one another, and consistent throughout?—None whatever. They are named by independent workers on their own powers of determination.

7750. Do you suppose that much discrepancy would be found if a comparison were made between the two?—No doubt very great discrepancy, inasmuch as when you are dealing with materials that vary so very little, and have for their determination short diagnostic descriptions, it is extremely difficult for two men working perfectly independently to arrive at precisely the same reasons as to the value of the diagnosis in relation to, say, half a dozen allied specimens before them.

7751. Do you suppose it would be desirable for the interests of science that the two collections should be compared?—Practically they are, in the interests of science. Workers seldom publish without working at the herbaria at Paris, in London, and at Kew, and at all the great herbaria. I do not mean those particular places alone, but also Geneva and other great herbaria. When anyone is engaged in any great exhaustive work he must consult all of them.

7752. There is no arrangement at present by which it is possible actually to compare those specimens about the naming of which there might be discrepancies; in fact, you cannot send specimens from the museum to Kew, or specimens from Kew to the museum, in order to compare them one with another?—No specimens of any kind received into the museum can be allowed to leave the museum except under very exceptional laws, which would never be put into operation under the circumstances to which you refer.

7753. Do you consider that the maintenance of that strict rule is for the interest of science?—I believe it is on the whole. There are disadvantages connected with it, but there are advantages which seem to me to be more important.

7754. (Dr. Sharpey.) I think you attach great importance to the proximity of the botanical collection of the British Museum to a great general library?—Yes.

7755. Do you think that the removal of the botanical collection from its present site to South Kensington will be seriously prejudicial, by depriving you of that advantage?—I believe that it will be a serious injury to science if the removal takes place, but I suppose that that is decreed, and must take place; but it will be an injury to science, which it would be impossible ever to recover in some aspects of scientific investigation.

7756. Do you not consider that the collection at Kew and the collection in the British Museum might be scientifically used for two different purposes in any way?—Practically it is so: according to the original notion of the foundation of them, and according to the uses of them, the herbarium at Kew is employed for the naming of plants, as Dr. Hooker says, in the gardens, and in the museum of "Economic Botany;" and the fundamental notion of the collection at the British Museum is for the study of systematic botanists.

7757. (Chairman.) Are there any instances upon the continent, at Paris, or Berlin, or Vienna, of duplicate collections similar to those which we have in this country?—I am not aware that there are any such collections.



7758. In most cases probably the botanic garden is nearer to the capital than is the case in this country?—In Paris certainly it is in the capital; but just there, as here, the systematic botanists consult the herbarium and not the garden. In Berlin it is in close proximity, although not actually in the metropolis.

7759. If the botanical and other natural history collections are moved to South Kensington, do you consider that it will be necessary to have a subsidiary library?—It would be absolutely necessary; and I believe that unless the value of the herbarium were to be greatly destroyed, the Banksian library will be required to form a portion of that subsidiary library, inasmuch as the Banksian collection was in continual use while the Banksian herbarium was being formed, and the volumes that form that library were anno-

The witness withdrew.

GEORGE ROBERT WATERHOUSE, Esq., examined.

7761. (*Chairman.*) I believe you are Keeper of the Fossils at the British Museum?—Yes.

7762. Several of the officers of the museum have been before the Commission, and we thought it desirable to give you an opportunity of making any statement to us with regard to your department, or of supplying us with any information which you may think desirable.—I am most willing to give any information in my power.

7763. Can you name any points connected with your department to which you think it desirable that our attention should be directed?—I did mention, in answer to the letter from the secretary, that I should be more specially prepared to give answers to any questions relating to the arrangement of the collections and also as to the mode of making them as instructive as possible to the public. I thought those two questions were very important.

7764. We should like to hear your views as to the arrangement of the collections under your superintendence?—When it fell to my lot, something like 20 years ago, to endeavour to get the fossils in order, of course the classification or arrangement was one of the points which it was most important for me to determine upon. At the same time the Museum of Practical Geology in Jermyn Street was under arrangement, and I thought it would be well were the two institutions to arrange their collections so as to teach from different points of view. I consulted with Sir Roderick Murchison, and having ascertained that the fossils in the Museum in Jermyn Street would be arranged stratigraphically, I determined to adopt a semi-zoological and a semi-geological arrangement; that is to say, the specimens of each of the leading zoological groups should be arranged together, but subdivided according to the geological strata from which they had been derived. Taking the fossil sea-urchins, for example, it will be seen that all the species are collected together, but, as arranged in the table cases, the sea-urchins of the most recent strata (the Tertiary) commence the series, and are followed by the species of the chalk, oolite, lias, and so on, according to the geological strata, in a descending series. In a strictly geological arrangement the sea-urchins would be distributed in many different exhibition cases, and often widely separated from each other. These remarks refer to the different zoological groups taken separately. I am sorry to say that for want of space, I have been unable to arrange the groups in their proper succession. Besides the general Palæontological Collection, we have a series of rock specimens. These are arranged geologically. Where the rocks are fossiliferous, specimens have been selected in which are embedded some of the most characteristic fossils of the rock.

7765. You think that the principle upon which you decided has been proved by experience to be most satisfactory?—The arrangement adopted has been found very convenient, since the persons who study these objects (and often publish the results of their investigations in the form of Monographs) are enabled

tated by the workers in the herbarium, so that if the books were left behind and the plants separated anywhere from the annotations on the books, the value of the plants in their cross references to books would be completely destroyed.

7760. Are there any other points in relation to your department which you think desirable to bring before the Commission?—No; I think I have exhausted all the points that I have made any notes of. I have referred to the facilities for consulting the collections which have been the same from the beginning, and, as far as I know, there is perfect freedom in examining anything in the herbarium accorded to everyone who asks for such a liberty, and this has been the practice, as I believe, from the beginning of the institution of the herbarium.

to see the whole of the group which interests them at one glance;—or, at least, the leading species, for a selected series is exhibited, and the remaining specimens are arranged in the drawers of the same table-case.

7766. In the event of the removal of the collection to South Kensington, you would follow the same system, would you?—I should.

7767. (*Professor Huxley.*) I presume that that is essentially what might be called a typical exhibition?—No; our collection is not an essentially typical one.

7768. But that principle of selecting the most important forms, and exhibiting them, and keeping a reserve of specimens in drawers, is what I understand by a typical collection?—Our exhibited collection then may be called a typical one in that point of view. I am not an advocate for exhibiting the whole of our specimens: were they exhibited, a very considerable number of them could not be distinguished, as seen from the outside of the cases, and a multitude of such specimens has a tendency to confuse and weary the visitor, rather than to instruct him. In the National Museum of Natural History, however, a liberal display may be expected, and it is desirable that a good idea should be conveyed of the wonderful variety which the objects of natural history present.

7769. What is your opinion as to the propriety of incorporating a fossil collection among recent specimens; how far would you be disposed to carry that?—Fossils exhibit only the hard parts of the animals which they represent, and are sometimes mere fragments; and, generally, I do not think it would be desirable to mix them with the recent species; but, on the other hand, recent specimens may very advantageously be introduced amongst the fossils, to render the latter intelligible to the ordinary visitor.

7770. I presume you would think it very instructive to put, we will say, a specimen of the Ichthyosaurus and a specimen of the Pterodactyl among recent Reptilia, in order to show the modifications of the group?—I should see no objection to that.

7771. There would be great practical difficulties in endeavouring to interpolate fossil collections, as a whole, among the recent ones, would there not?—Yes.

With regard to making the collection instructive to the public, it so happens that of late years the number of students has increased very much, but beyond that a custom has crept in, which is a very excellent one, that of lecturers bringing their classes to the museum and delivering lectures on the objects in the galleries. Besides which, some working-men's classes have visited the Geological Department on private days, and have had lectures or explanations, sometimes from the officers of the department, and sometimes from other persons who have accompanied them. These lectures and explanations are not of a formal nature, and I fancy are the better for that. They evidently give great satisfaction. I think it would be well if they were extended to young persons, schools,

W. Carruthers,  
Esq.  
28 April 1871.

G. R. Water-  
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28 April 1871.

&c. I believe if such were the case, it would, in many instances, be very beneficial, through the impressions which would more readily take root in the young mind.

7772. (*Chairman.*) At what age do you think that young persons are capable of deriving advantage from such formal lectures as these?—Even at nine or ten years of age I believe it would be a very good thing.

7773. Do school children of that age come there for that purpose?—We have a good many schools come there, but I do not think that anybody has explained the things to them. They have come on the public days and walked through. The other societies, if I may so call them, have come on the private days and have always been admitted. They have made application and have received a general permission to come, but it would not do on public days, it would block the thoroughfares altogether.

7774. Is there any other point upon which you would like to give us your views?—I scarcely know of anything in particular. I am only anxious to give every information that is in my power, and I should be very happy to answer questions upon any point.

7775. I do not understand, with reference to the last portion of your evidence, that you would think it desirable to annex the duty of lecturing to that of keeper of a department?—I do not think that at all desirable.

The witness withdrew.

Adjourned to Tuesday next, at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Tuesday, 2nd May 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

G. C. Foster,  
Esq., B.A.,  
F.R.S.

2 May 1871.

GEORGE CAREY FOSTER, Esq., B.A., F.R.S., examined.

7779. (*Chairman.*) You are the Professor of Physics in University College, London?—I am.

7780. Will you be so good as to furnish the Commission with an outline of the nature and extent of instruction in physics given in that College?—The instruction is given in several classes. There are two classes, called the senior and junior, and, in addition to those, a class of applied mathematics, which is more or less connected with the study of physics; and in addition there is practical instruction in a physical laboratory; and besides that there is still an elementary course of physics, which cannot be considered as a permanent part of the college work, but is frequently given; it goes on for about three months in the summer, and is preparatory to the more thorough courses. The instruction in the two principal courses of physics, the senior and junior physics, as they are called, is chiefly based upon experimental demonstration, but in the senior class especially the mathematical developments are carried as far as they easily can be without the employment of high mathematical methods.

7781. In the applied mathematics class, the higher mathematics, I presume, is required?—Yes; the subjects are treated more especially from a mathematical point of view.

7782. Is there a large number of students at University College preparing for the examinations of the University of London?—It is difficult to say precisely what proportion, but I should say that probably half at least of the students in the Faculties of Arts and Science are preparing for some examination or other of the University of London.

7776. But what you wish is, that the collections should be made available for other persons?—I see no objection to one of the officers going out in the way that I have spoken of, seeing those people there, and explaining the objects to them, but to make it a formal thing I think would interfere very much with their ordinary duties—the staff would have to be increased.

7777. (*Professor Smith.*) Of course, if it were desirable, the staff could be increased, but you think that it would be undesirable to have systematic lectures in connexion with the British Museum?—I think it very desirable to have lectures to teach the public the nature of the objects which we are exhibiting, but with regard to regularly appointed lecturers I have some misgivings, having during my experience in attending lectures noticed that after a time they are rather apt (to use a common phrase) to grind up the same old material again and again. I have attended lectures at institutions where lecturers are appointed for a long period, and, after considerable intervals of time, I have found little or no change in the matter delivered by them to the audiences.

7778. But they were given to different audiences, though they might be the same lectures?—The audiences were, no doubt, different, but in cases such as I have alluded to they will be limited in number; they very soon decrease if a lecturer does not introduce into his discourse the latest knowledge and discoveries on the subject which he has to deal with.

7783. What, in your opinion, is the influence which the University examinations have upon the study of physics at University College?—It appears to me that the examinations of the University tend to discourage more than a very elementary study of the subject, for I find, as a matter of experience, that I cannot get students to give more than one year to the subject. My own classes are arranged so that the intention is that students shall pass through the junior course in their first year, and then pass on to the senior; but I have never obtained more than eight in the senior class, and, at present, I am lecturing to a class of five. The way in which that result is brought about by the University examinations I conceive to be this: that the only examinations in which experimental physics is required at all are the first examination for the Bachelor of Science degree, and the Preliminary Scientific medical examination. These are supposed to be taken a year after matriculation, so that candidates preparing for these examinations cannot usually give more than one year to the study of the subject. After that, unless they proceed to the exceptional degree of Doctor of Science, they are not by the University regulations obliged to study physics any more.

7784. In your opinion, is the standard for the Bachelor of Science degree in the University of London too low?—I should not say that the examination, as a whole, is too easy, but I do think (it may be from a partiality for my own subject) that there is too little physics required.

7785. Would the knowledge acquired by your senior class not be available for any candidate except



for the degree of Doctor of Science?—It would be useful for a candidate for honours, even at the first examination for the bachelor's degree, but I do not find that candidates do take that class in order to prepare themselves. I have at present in fact only two in the senior class, who are, as far as I know, proceeding to any examination at all in the University of London.

7786. You stated that your senior class had never exceeded about eight?—I think eight is the highest number that I have ever had.

7787. Is the junior class much more numerous?—In the first year that I was professor I had 50, and the average has been between 70 and 80, or, rather, I should say that is the average of students attending the two classes together, so that if you subtract eight from that it would give about 60 or 70 as the number of students attending the junior class.

7788. With regard to the other classes of which you spoke, is there any considerable number of students attending the class of applied mathematics?—That, I believe, has had an average of about 25, but it has only been in existence under that name for the last three or four years.

7789. Do students attend that class with a view to the examinations of the University of London?—I believe that is chiefly taken by men who are preparing themselves for the first Bachelor of Arts examination, or for the first and second possibly.

7790. Do you think that if a larger amount of experimental physics were required from a candidate for the degree of Bachelor of Science, your senior class would be more largely attended?—I believe so.

7791. And, to that extent, the demand for an extended course of instruction in physics is limited?—Yes.

7792. Is there any other cause which you consider tends to a limitation of the demand for instruction of this kind?—There are causes which limit the study of science in general, which, of course, apply to this subject as well, but I think that to some extent specially they act against the study of physics. In the case of chemistry, for instance, there is a good out-look for the practical application of knowledge of the subject; whereas, in the case of physics, there is as yet little demand in practical life for a knowledge of the kind, and to study it with a view to purely scientific objects there is very little inducement indeed. In fact, as far as I am aware, except in a very small number of exceptional cases, a bare livelihood can scarcely be obtained by the devotion of a life to the scientific pursuit of physics.

7793. Is it the case, that but few of the large manufacturing establishments consider that there is any advantage in having in their service persons with a thorough knowledge of physics?—The only demand for physical knowledge, that I am aware of, to any considerable extent, is in connexion with telegraph works. That is coming now to be rather an important sphere, but that is quite recent.

7794. Have any of your students obtained employment in works of that character?—I have had several students who have been specially preparing for the Indian telegraph service, and some of them have taken very high places in the examination, but I do not remember distinct cases in which they have gone into private employment as telegraph engineers, or anything of that sort.

7795. Is any other field, in your opinion, likely to open itself for the employment of students of physical science?—I think there is a rapidly growing demand for teachers of physics in the better class of schools, and I believe that the demand which already exists cannot be supplied.

7796. Is the inducement of employment in those schools too small to amount to much encouragement?—Hitherto I believe the practice has been for some master already in the school to take physics as a subject which he could add on to his previous work. Very often the mathematical masters have taken that as a subject which they could easily get up in a

short time. There has not been much systematic preparation for that kind of life.

7797. May we understand that very few of your students would look to employing themselves hereafter as teachers of physics in schools?—Our students are on the whole so young that very frequently they have not formed very definite intentions as to their future occupation. It is only accidentally that I now and then know to what occupation they do devote themselves.

7798. Do you consider that practice in the use of apparatus and in methods of observation is essential in a thorough course of instruction in physics?—I think it is quite as essential in the case of the study of physics as in the case of chemistry, where it is always admitted to be of importance, and especially for teachers. I think it is absolutely essential that they should know by personal experience and familiarity the phenomena that they deal with in their teaching.

7799. Is the physical laboratory of University College sufficiently supplied?—It is in want to a great extent still of apparatus, as well as of more suitable rooms. Those are the two wants which I should especially point to in the way of instrumental appliances. The rooms that we have are both insufficient in space, and they are very unsuitable; they are very unsteady, and frequently I find that the students are quite unable to go on with their operations; and as the result of that they get discouraged, and from the inaccuracy which is unavoidable in a place that is not steady enough, they get careless in their work, and it operates very prejudicially in that respect.

7800. The rooms were not originally constructed, I presume, with a special view to this application of them?—No; the physical laboratory has only existed for the last five years. The instruction in physics formerly given was confined to lectures. A large lecture room was provided, and a room for keeping apparatus, but no place in which it was intended that experimental investigations should be made, or practical instruction should be given.

7801. This deficiency, I presume, could only be remedied by the application of a considerable amount of money?—To provide rooms would certainly require an outlay of some thousands of pounds, unless other rooms in the building could be set at liberty for the purpose of a laboratory.

7802. Do you consider that instruction in physical science is seriously interfered with in University College from the want of sufficient command of money?—I do distinctly.

7803. You have already stated that several thousand pounds would be required to provide an adequate laboratory, and is money required for other purposes as well?—It is very desirable indeed that there should be connected with the laboratory several assistants, not merely to repair and make apparatus, but also to take a part in the teaching. I think, both for the benefit of the students and of the gentlemen themselves who might be so engaged, that would be an exceedingly desirable result. There is work enough for perhaps half a dozen besides myself.

7804. Can you state the amount of the income which is now applicable to instruction in physics in University College?—The whole of the money applicable to such purposes is that derived from the fees of the students, and this has amounted of late years to a sum, on the average, I should say, of between 400*l.* and 500*l.* per annum, which has to be divided between the Professor and the College. In addition to the fees of my class I may say that I am allowed by the College at present the sum of 100*l.* a year to pay an assistant, and to provide additions to the apparatus; but that is an arrangement which has only been entered into within the last 12 months. Previously to that, the sum of only 50*l.* was granted for an assistant. As to apparatus, I had to apply for them from time to time when special things were required. In order to start the physical laboratory at all, I considered it of such importance that I proposed to the council to make any additional outgoings that might be required a first charge upon

G. C. Foster,  
Esq., B.A.,  
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2 May 1871.

the income of the laboratory, so that one year in which the income was about 37*l.* the whole of that went to pay the expenses, and I got nothing by it. In another year the council took 80*l.* out of 120*l.*, and so on.

7805. (*Dr. Sharpey.*) The assistant that you refer to is not a teaching assistant, is he?—No; he is exclusively employed in making and repairing apparatus, and in taking charge of the apparatus.

7806. (*Chairman.*) You think that one assistant is not sufficient?—One assistant is sufficient for that purpose, but I think that teaching assistants are very desirable. In fact, I feel quite conscious that I cannot give as much instruction as is required; as much in fact as there is a demand for.

7807. Do you think that instruction in physics cannot adequately be provided for, unless funds are derived from some other source in addition to fees?—I am strongly of that opinion. I think the result of experience shows that that is the case. I have pressed repeatedly upon the Council of University College the necessity, in order to maintain the school of physics in an efficient state, that there should be a yearly sum at the disposal of the Professor of Physics. They did not see how this was to be provided, and in order to provide the money, 12 months ago, they raised the fee of the class, which has had the result, I believe, of decidedly diminishing the income; so that we are already squeezing out of the students as much as we can get.

7808. Can you state what the amount of fees is at present?—For each of the courses of lectures, which extend from the beginning of October till the middle of June, a course in which three lectures a week are given to each class, the fee is at present eight guineas, of which one guinea may be considered as the payment towards the apparatus fund, and seven guineas is divisible between the College and the Professor.\*

7809. You state, do you not, that the scale of fees has been lately raised?—Yes. Until the beginning of the present session the fee for the same classes was seven guineas; it is now eight, the additional guinea being intended as a payment for apparatus.

7810. Has the additional guinea had the effect, do you think, of reducing the number?—The number of students is decidedly smaller this year; it is 62, I think, as compared with 76 last year. Of course it is difficult to say what is the precise cause, but I am inclined to attribute it to some extent to the increase of the fee.

7811. What portion do you retain of the fee fund yourself?—That depends upon the total amount. The arrangement is, that if the total income of the chair exceeds 300*l.*, the Professor takes two thirds of the whole amount and the College one third; below that there is a different arrangement, by which he gets a slightly greater proportion.

7812. The College, I think we may understand, has no prospect of being able materially to increase the amount of funds applicable to instruction in physical science?—I am not aware that there is any prospect of any increase.

7813. (*Professor Huxley.*) You speak in your *précis* of the desirableness of imposing an entrance examination on students seeking to enter the classes, and especially the laboratory; that would be the physical laboratory, I presume?—Yes.

7814. Do you think that that is possible at present; would you not shut out a great number of students altogether?—If we were in a position to require them to come with a certain degree of preparation, they would probably bring it, but at present we are obliged, from our pecuniary condition, to take all the students that we can get.

7815. Would not the best preparation for your laboratory be elementary physical instruction in the

school?—I think it would be a very desirable preparation indeed, and I make it a condition now, and I have introduced it into the prospectus, that students wishing to enter the laboratory shall either have attended one of my courses of lectures, or have obtained equivalent instruction elsewhere.

7816. Is any elementary instruction in physics suitable for boys given in University College School, as part of the regular work of the school?—Experimental lessons are given, in which, I believe, the master makes experiments. I do not think that the boys themselves have any opportunity of using apparatus.

7817. Do you not think that it would be very practicable to introduce elementary physics into schools; of course, I do not mean the precise and refined methods which you yourself would have, but that boys might be made acquainted with the elementary facts of electricity, the elementary facts of magnetism, the elementary facts of heat, and so on, that that might form a part of the school instruction?—I think with very great advantage and very easily.

7818. And that would serve, in a measure, would it not, as an introduction to the more serious study of physics in your own class?—Yes.

7819. Do you think that there is much practical difficulty in carrying that out in the boys' school; supposing you had unlimited funds, should you find a difficulty in teaching the boys at University College School elementary physics of that kind?—I do not see any difficulty at all in teaching them by lectures, but to organise practical instruction in which they should actually make experiments themselves, which I think is by far the preferable method, is no doubt difficult, but I should think that arrangements might be made.

7820. It is more a question of finance and room, and the assistance that is to be got, than anything else?—Yes, I think it is.

7821. (*Professor Smith.*) With reference to the entrance examination which you speak of as desirable, do you find that the students who come to you are wanting in the mathematical knowledge that you find requisite?—Frequently they are, and it makes the lecturing to a large class very difficult; some of the members of the class really know nothing of mathematics whatever, and are quite frightened if I use the simplest algebraic or trigonometrical formulæ, whereas others feel it tedious if I do not get on faster, and omit the elementary demonstrations.

7822. If you had an uniform examination, you would very likely require preliminary mathematical training?—Yes. I think that elementary mathematics would be an important part of the examination.

7823. In what branches of physics are you, under your present circumstances, able to give practical instruction in the laboratory?—The subjects in which most of the students have worked in the laboratory are heat, magnetism, and electricity. Frequently one of the first things that I put them to, in order to see what they already know, is to determine a few specific gravities, and some of the simplest physical measurements of that kind; but heat, electricity, and magnetism are the staple subjects of the work.

7824. With regard to light, you have not had students, perhaps, who are far enough advanced to study it experimentally?—That is one reason; but another is the difficulty of providing accommodation for optical experiments. That necessitates, of course, a dark room, and as my rooms are limited in number I cannot darken one of them and put one man in the dark when the others are working in the same room at the same time.

7825. With reference to the examinations of the University of London, is it not true that in the examination for the Doctor of Science degree, there is ample encouragement for the study of physics, at least for those few persons who go in for that degree?—Decidedly. But that, I conceive, does not much affect our teaching in University College. A man who is preparing for the Doctor of Science degree would probably be a man

\* Students are allowed to enter either class for one or two terms only, instead of for the whole session, consisting of three terms. In this case, they pay three guineas a term, half a guinea of which goes to the apparatus fund.—G. C. F.



who would either study by himself, or, at most, he would work in the laboratory: he would not be attending lectures, if he were preparing for a degree so high as that.

7826. But he would require instruction in a physical laboratory, would he not?—Yes, I should think that that would be the main part of his course of study.

7827. Have you had in your laboratory any candidates as yet for the Doctor of Science degree who have studied in your laboratory with a view to obtaining that degree?—I have not as yet had any; in fact, I believe the only candidate who has as yet presented himself for the degree of Doctor of Science in experimental physics is a gentleman who had prepared himself by private study exclusively.

7828. Then, practically, there are very few candidates for a degree in the department of experimental physics?—As yet, I believe, that is the solitary instance of a candidate.

7829. (*Dr. Sharpey.*) I presume that the deficiency in the examination of the University of London, as regards physics, applies to the examination for the Bachelor of Science and the Bachelor of Arts degrees, does it not?—In what I have said I had especially in view the examination for the Bachelor of Science; for even the examination for the degree of Bachelor of Science only requires that one year's study should be given to the whole subject of physics, and that I conceive to be utterly inadequate to get even a fair acquaintance with it.

7830. But do not two years elapse between the matriculation and that examination?—It is frequently only half a year between the matriculation and the first examination for the Bachelor of Science. I think I am correct in saying that candidates who matriculate in January frequently proceed for the first examination for the Bachelor of Science in the following July.

7831. But there is an examination, is there not, in mechanical and natural philosophy in the second examination for the Bachelor of Science?—Yes; but that is an examination in those subjects from a mathematical point of view, not from an experimental; and the subjects of heat, magnetism, and electricity are not part of the examination at all.

7832. How would you propose to remedy that, supposing you were to suggest an amendment?—I have not considered the matter sufficiently to attempt to go into details, but I think that the second examination for the Bachelor of Science degree should include an examination in physics, and also that a practical examination ought to be required at the same time, as is required in chemistry, for instance.

7833. That is to say, a further examination in those subjects which you mention—heat, magnetism, and electricity?—Yes.

7834. And also a practical examination?—Yes.

7835. Do you apprehend that there would be any difficulty in conducting a practical examination in physics at the University?—I believe there would be a difficulty, but by no means an insurmountable one. It is already done, I believe, at Oxford in the case of all candidates who go out in the school of natural science.

7836. With reference to the apparatus, do your remarks, as to the deficiency of apparatus, apply to the apparatus required for the illustration of the lectures, or the apparatus required for extending practical instruction in the laboratory, or to both?—The deficiency is chiefly felt in the laboratory. Gradually I have got together a pretty good collection of merely illustrative apparatus, such as would be employed in lectures, but I am still very much in want of expensive measuring instruments of various kinds.

7837. Is there any separate fee charged for the laboratory?—Yes, there is.

7838. What is that?—I believe the fee for the whole session is 18 guineas,\* but that may be broken up into periods as short as a month. Students may enter, and

frequently do, for a single month, and work only three days in the week during that time, for which they pay 2½ guineas.

7839. But you do not think that the laboratory fees would cover the expense of apparatus and assistants: there is no hope of that?—No, not for a long time to come, at any rate.

7840. Supposing any aid were given from other sources than the College itself, say aid from the State, to such institutions as University College or Owens College, or King's College, under what conditions could such pecuniary aid be granted, do you think; as to whether there should be any corresponding fund raised by other parties than the Government, and whether there should be any supervision or inspection exercised, on behalf of the State, as to the application of this money, and the use made of it?—I think there could be no possible objection to the exercise of any supervision that might be thought needful, but I think that what has already been done in raising money for the College might well be set against anything that may be done in future by the Government. To impose any further effort of the same kind as a condition would, I think, be almost unreasonable.

7841. You consider that the efforts already made by the College and its founders are quite sufficient to set against any subsidy from the State?—Yes, I consider that such efforts have been made, and so much has resulted from them as to give a decided claim for encouragement, so far as the evidence of private effort should be required as a condition for receiving public aid.

7842. With reference to the students in electric telegraphy, have those been in any engineer's office before they come to you?—Not usually. I believe in one or two instances they have, but the majority have come from all kinds of employments, not having devoted any attention to the subject before.

7843. With respect to engineering students generally, do you think that it is most advantageous to begin at once in a college, or to begin in the first instance by serving a short time with a practical engineer, and then after their college course continuing in a practical office?—I have no very decided opinion upon that point, but my feeling would be that the proper beginning was in the general studies in the college, and to take the practical course afterwards.

7844. (*Chairman.*) Have you formed any estimate of the annual sum which, in your judgment, would be required for the efficient organisation of your department at University College?—I think, if we were once supplied with suitable buildings, that a sum of from 200*l.* to 300*l.* a year would be sufficient for all essential outgoings.

7845. Would that include the payment of assistants?—Yes. I believe that it will be easy to get young men to aid in the teaching of students for little or no remuneration; for instance, that men who are looking forward to employment in schools as teachers of physics would be glad of the opportunity of assisting at lectures, in the preparation of apparatus, and in experiments, for the sake of the mere experience that they would gain. I have recently had, I may mention, a gentleman, who is a teacher of physics at one of the large public schools, working in my laboratory, simply for the sake of familiarising himself with the use of the apparatus.

7846. Is there any other point upon which you would like to make any additions to your evidence, or to which you have not sufficiently called our attention?—I am strongly of opinion that one main object to be answered by any aid that may be given to the College at any future time would be, making the teaching, which is already given there, more accessible to the public. I feel strongly that our fees are far too high for the thorough utility of the institution. I think also if it were possible to introduce assistant teachers, something upon the plan which, no doubt, the members of the Commission are familiar with in Germany, namely, of the *Privat-docenten*, it would be an exceedingly valuable addition to the present

G. C. Foster,  
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2 May 1871.

\* This is an error: the fee for the whole session is 20 guineas.  
G. C. F.



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F.R.S.  
2 May 1871.

system. It would give young men an opportunity of learning the methods of teaching, and it would give also a distinct means of entering upon a scientific career, and enable the patrons of educational institutions to judge between the candidates for appointments, and would give them the means which they do not at present possess for estimating their qualifications.

7847. You spoke just now of a grant of from 200*l.* to 300*l.* a year being adequate for the efficient organisation of your department of teaching at University College. Do you think that if the Government were to assist you with that sum annually, you would be able to reduce the scale of fees?—No, I do not. I am supposing that that money would be expended simply for apparatus and assistance.

7848. Then the further object which you consider so desirable to carry out could not be attained unless you had assistance to a larger extent?—No, it could not.

7849. Instead of eight guineas a course, what do you think, if you could carry out your own views, ought to be the amount of the fees required from students?—I think three guineas, instead of eight, would be quite a sufficient payment.

7850. Should you look to the number of students being materially increased thereby?—I think that would no doubt be the result in the course of time.

7851. Could you, in your department, undertake the instruction and management of a much larger class than you have at present?—I could not do so efficiently without assistants. I think that I have as much teaching on my hands now as I can properly perform.

7852. (*Professor Smith.*) Would you also think it advantageous to reduce the fees of the laboratory as well as the lecture fees?—Decidedly.

7853. Do you find that they are at present too high, really, for the means of the persons who wish to attend?—I do not know that evidence of that has presented itself to me; in fact, as yet, the demand for instruction in the laboratory is very limited; it is rather the absence of any inducements to devote time to the study of physics, than the high fees, which prevents men from coming to the laboratory in larger numbers, I think.

7854. (*Mr. Samuelson.*) Have you felt, at University College, that there is any competition between the Government Schools of Science, either the Elementary Classes or the School of Mines, and an institution like University College?—We have felt that upon various occasions in the loss of teachers.

7855. What becomes of those teachers?—I may mention that the Professor of Engineering, Professor Fleeming Jenkin, left us to go to the chair of engineering in Edinburgh, which is partially endowed by

The witness withdrew.

Government. A case which is perhaps not exactly of the same kind, was that of the loss of Professor Hirst, who would have certainly remained at the College if the remuneration of his chair had been a little higher.

7856. Was he attracted to some institution which had an endowment?—He was attracted to the University of London, where he is now Assistant-Registrar, which is, of course, an institution supported by Government funds, but not one that competes with us in a direct way.

7857. Then, if the Government action were to be extended in its area, would you be afraid that that would affect University College still more injuriously in this sense?—I have no doubt that it would. We suffer at present very much from a difficulty in offering inducements to well-qualified professors to take our chairs, and if there were a greater demand elsewhere, that, no doubt, would increase the difficulty which we already feel.

7858. Assuming that the direct action of the Government in teaching were to be extended, can you suggest any way of counterbalancing the competition which would be likely to arise?—I believe that the competition itself is exceedingly desirable.

7859. Competition for teachers, I mean?—I understood you to be alluding to the teaching. The only mode of counterbalancing that would be to put us in such a position that we could offer equivalent inducements.

7860. What guarantees do you consider that University College, or any other teaching institution putting forth a claim of that kind, should offer to the Government, in return for any assistance which they might grant?—That is a point which I have not previously considered. I think that any inspection or record of results that might be required could easily be furnished.

7861. You hesitate as to the mode, but you have no hesitation as to the possibility of affording a sufficient guarantee that the Government fund should not be misapplied?—I think there would be no possible difficulty in affording any guarantee that might be thought needful.

7862. Is it at all probable that the governing body of University College would hesitate as to allowing Government inspection or Government interference in some reasonable shape?—I have never heard that they have expressed an opinion upon the subject, and, therefore, perhaps, it would be useless for me to say what I think they would do.

7863. But you think it would be reasonable, on the part of the Government, to require guarantees that good results should follow from any Government aid?—Decidedly; any aid that was given, either to University College or to any such institution, I should wish to see given under conditions which insured its proper application.

WILLIAM BENJAMIN CARPENTER, Esq., M.D., F.R.S., examined.

W. B. Carpenter,  
Esq.,  
M.D., F.R.S.

7864. (*Chairman.*) You are Registrar of the University of London?—I am.

7865. In that capacity, have you had opportunities of observing the qualifications and attainments of those who come up for examination?—Yes, very considerable opportunities.

7866. What is your experience as to the quality of the scientific instruction given in the colleges connected with the University, so far as any conclusions may be drawn from the character of the answers?—When the candidates have gone through, with care and attention, the course of instruction which will qualify them for our scientific examinations, I find that they come up well prepared; but a very large proportion of them do not go through such a course of instruction. And, perhaps, it would be desirable to make a distinction between the Matriculation examination and the higher Scientific examinations. In the Matriculation examination we do not consider that candidates would be likely to go through

a college course. Those who are prepared expressly for it in schools go through a course of instruction in their schools; but as a very large number get no school instruction at all in the scientific subjects, they have to prepare privately. I am speaking now of the Matriculation examination, and we find, practically, that, in natural philosophy especially, the preparation is extremely bad, that the style of answering generally is very imperfect, and very great ignorance is shown of the subjects—an ignorance arising from the want of the power of applying their minds to them. The candidates who have a certain amount of knowledge of science are not able to reason upon their knowledge, and to answer questions that go a little out of the ordinary routine of the books in which they prepare. That strikes me very forcibly as the result of preparing merely from text books, without any kind of objective instruction,—without being led to know what those principles and formulæ really mean in relation to the actual phenomena of science.



7867. What is the average age of those who come up for the Matriculation examination?—A very large proportion are between 16 and 18. We consider that the Matriculation examination should test a good and complete school education. A great many older men come up; but those are generally men who have had an inferior early education, and that is shown by the very large proportion of rejections of those older candidates. We find that the smallest proportion of rejections, and the largest number who pass in the higher division of honours, or in the first division, are candidates between 16 and 17 who come up from good schools.

7868. Are there exceptions to the general deficiencies of which you have been speaking in particular schools?—Yes, decidedly; there are candidates who come up from particular schools extremely well prepared in the scientific subjects.

7869. Then it is clear that scientific instruction can be well given in schools to students of that age?—I have not the smallest doubt of it, and I consider it extremely important that it should be so, as a mere matter of mental training.

7870. With respect to the subsequent examinations, is their character generally more satisfactory?—The candidates who come up for the special examinations in science, *i.e.* the first and second examinations for the degree of Bachelor of Science, are of two classes: some of them are carefully and earnestly applying themselves to scientific study, and go through the requisite courses of preparation for it; and those candidates come up generally well prepared, or if they fail, it is in some particular department of science. Candidates who do extremely well, for instance, in chemistry, may fail in botany; or candidates who do very well in zoology and botany, may fail in natural philosophy; but we have a large proportion of candidates who go through a very careful course of scientific study under extremely good professors. Then, there is another class of candidates who come up for the scientific examinations, thinking it an honour to obtain a degree in science, and supposing that they can obtain that honour without a full scientific training, and those candidates most generally fail; some think that they can prepare themselves from books chiefly, and from private study, and these almost always fail.

7871. Are they the candidates who have entirely been educated at home, and who have not been to any college?—Generally speaking it is so; or it happens, not unfrequently, that they are candidates who have taken a degree in Arts, and have come up for the Scientific degree, thinking that they can pass in the additional subjects; for those who have graduated in Arts are allowed to come up for the Scientific degree by passing in additional subjects which are not common to the two. Certain subjects are common to the two, such as mathematics, logic, moral philosophy, and mechanical philosophy; and they think that they can easily get up the additional scientific subjects by private study, and present themselves for examination:—those candidates almost invariably fail.

7872. They have not had the advantage of any practical or objective instruction, such as you consider so essential?—No, they have not.

7873. You have also acted, have you not, as Examiner in Natural Science in the Civil Service examinations?—At the request of the Civil Service Commissioners, for three years, I conducted the examinations in zoology and botany for the Indian Civil Service examination.

7874. How far do you find the candidates for that examination prepared?—With very few exceptions I have found an extremely low state of preparation, which I have been the more surprised at, since those are optional subjects. I should have expected that candidates would not have presented themselves, who had not really given a fair amount of attention to the subject; but the candidates have presented themselves showing a most extraordinary ignorance; indeed, I may say, ignorance even of the very commonest things. If

I may give an example, one of my questions, two or three years ago, was to give the points of resemblance and the points of difference between a whale and a fish; and one of the candidates said that the principal point of difference was, that the whale had much stronger gills than the fish, and could breathe, therefore, at much greater depth.

7875. Are the candidates for the Civil Service examinations altogether of a different class from those who come up for the examinations of the University of London?—No, I cannot say that, because we have frequently had the same men going up. I think, as to the candidates for the Civil Service examinations, that by far the larger proportion take classics, mathematics, and English as their principal subjects; and there are some who have a scientific turn, and think they may get additional marks by Science; but I find that a large proportion of those who come up have really no scientific culture of any value, that they have taken up books and read them and tried to commit them to memory, without any real knowledge. For example, I have been accustomed to test candidates upon one or two points, out of curiosity; and I have found that candidates who could repeat very fluently a definition, did not know how to apply that definition to the objects. For instance, if I asked them how they would know a Mammalian skull from a Reptilian skull, they would repeat a definition; but when I put a skull into their hands, they would not be in the least able to tell me whether it was a reptile's or a mammal's skull.

7876. Are you speaking now of the Indian Civil Service examination?—Yes; but I believe that that is the same with many of the candidates of our own examinations. I remember, for example, in one of our earlier science examinations, a Ruminant's skull was placed before a candidate, and he said, "It is certainly not a ruminant's, it is that of a beast of the forest." Now there is no Mammalian skull more easily recognised than a ruminant's skull. But I remember being particularly struck with one scientific candidate for the Indian Civil Service, two years ago, who could repeat to me almost verbatim, out of Professor Huxley's book, the definition of any class, but he had not the remotest idea of the nature of any object when placed before him.

7877. Did most of the candidates of whom you have now been speaking attempt to get up the subjects merely by reading books?—Yes, merely by reading. Now and then there would be a good man who had attended lectures and was familiar with the objects, but those were quite the exceptions.

7878. Have you been led to think that there are any essential defects in the teaching of science in any of the colleges or schools which send up candidates for the London University examinations?—I have not been led to think that there is any defect in the teaching of the colleges, if the candidates will only give their attention to the subjects. We have a very large number of failures, for example, in Botany in our scientific medical examinations; but I believe that those failures result from the idea of candidates that botany is such a very subordinate subject that they need not trouble themselves about it. Our examinations require a very small amount of knowledge of Botany; but what they do require is accurate knowledge, as far as it goes, and objective knowledge,—knowledge that shall enable the candidate to describe accurately a plant in technical language. He is not even required to name its natural family, but he is required to describe it accurately in a systematic manner and in technical language; and we find that a very large proportion of candidates fail in this; but I believe it is their own fault, and not the fault of their teaching. But with regard to the schools and the preparation in them for the Matriculation examination, I am quite satisfied that there are very few schools indeed where there is any really effective teaching; and that the great evil in the present system of ordinary school education is the ignoring of that exercise of the mind which science alone gives,—the observation of the

W. B. Carpenter, Esq.,  
M.D., F.R.S.  
2 May 1871.



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phenomena of nature, and the application of the mind to reasoning upon those phenomena. There is no branch of school education, putting aside science, which in any way cultivates those faculties. Classics, Mathematics, and English are all concerned with abstract ideas; but Natural Philosophy and Chemistry, which are, I think, in general, the subjects best suited to begin a scientific training upon, if taught objectively, exercise the powers of accurate observation. A good teacher will ascertain, by examination of his pupils, how far their observation has been accurate; and then, by bringing their minds to reason upon those facts of observation, they are trained in the elements of scientific and philosophical reasoning, which constitute a most excellent preparation for the higher study of science. As a boy, I was fortunate in being trained in this manner; and I am quite satisfied, from my own experience, and from the experience of the education of five sons, who have all been trained upon the same principle, that it is a most valuable part of intellectual discipline and culture.

7879. You have now been acquainted with the University of London for a good many years—do you see, so far as you can judge from the examinations gone through, any progress in the character of the scientific instruction given in schools?—I doubt if there has been much, excepting in a few schools. The general character of our candidates has not improved. We have more rejections in natural philosophy now than we have had at any time.

7880. (*Mr. Samuelson.*) Did you examine for the Engineering Department of the Indian Civil Service?—No, I did not.

7881. (*Professor Smith.*) It has been stated to this Commission, by some of the witnesses, that, in their opinion, one of the reasons why less original research in many branches of science is undertaken by young men in this country, as compared with young men in France or in Germany, is owing to the character of our University examinations, and that remark has been extended to the University of London as well as to others. Have you been led to form any opinion upon that point?—I think that the absence in the University examinations generally of anything that brings the mind into contact with science,—and again, the rewards which are given for proficiency in other subjects, for classics, mathematics, and mechanical philosophy,—have a great tendency to draw off into other directions powers which would be most advantageously devoted to science. If I may give an example, which is very well known to two members of the Commission: a gentleman who had graduated in Trinity College, Dublin, with great success, and taken a high degree there, came over to London, and entered at University College. He showed at our first Bachelor of Medicine examinations a most extraordinary proficiency. He took the three exhibitions in anatomy, in physiology, and in materia medica and organic chemistry. No such proficiency had ever been shown before. I believe Professor Huxley said that his papers in physiology were so well written, that he could not have done them better himself, or something of that kind. This gentleman, unfortunately, has since died; but the point to which I wish specially to direct the attention of the Commission is this: he assured me that when he first came over to London and entered Professor Williamson's chemistry class, he was, as he expressed it, so much at sea for the first six weeks or two months that he had doubts whether he should go on. He felt himself quite unable to comprehend the subject, to the teaching of which he was listening. Everyone knows that Professor Williamson is a most admirable teacher, and that he has specially studied the art of teaching; and there could be no question, in that case, that the fault was not in the professor. This gentleman did not like the idea of being beaten, and he determined to go on; and he applied himself during the remainder of the session with such success, that he carried off the gold medal at the college examination; and Professor Williamson told me that he had not had such a pupil for many years. The

point that I wish to impress on the Commission is this: here is a typical example of a man having extraordinary ability for the cultivation of science, a man who I have no doubt whatever, if he had lived, would have been a most valuable worker; and yet that man's mind was turned so completely aside from the direction of science by his education at Trinity College, Dublin, that when he first came to bring his mind into contact with science, he was completely at a loss to apprehend the meaning of scientific facts; and, if he had not been a man of perseverance and determination, he would have given it up altogether.

7882. It is sometimes alleged, is it not, that the Universities encourage knowledge of what has been already done; for example, that your degree of Doctor of Science is never given except to men who have shown really the greatest proficiency and knowledge, so that it is esteemed a very high honour, but that nothing is done by any of the Universities in this country to encourage original research or to invent any system of honour or university reward for original research; do you think it would be possible or desirable to change that in any manner?—I should be sorry to see it done excepting for the *highest* degree. I should be sorry to see any credit given for original research, except on the basis of the broader scientific culture which our Bachelor's degree requires. I think it might be quite possible to introduce it into the degree of Doctor of Science; but our system is pyramidal, so to speak, resting on a broad general basis. In our specification of subjects for the degree of Doctor of Science, there is a very wide range of subjects, in some one of which the candidate is expected to display very special knowledge; and I think it might be quite possible in such an examination to allow an opportunity for giving evidence of original research. We have that to a certain degree: there are several things that are left to the candidate's choice; thus, in Zoology and Botany a candidate may choose any department that he pleases, in which to go in for the highest and most critical knowledge. For example, in Zoology one part of the examination is a critical knowledge of the genera and species of some particular family to be selected by the candidate and approved by the examiner; so again in Botany, a critical knowledge of the genera and species of some particular group to be selected by the candidate and approved by the examiner; and if the candidate showed that he knew more about it than the examiner, that he had even passed the boundaries of the knowledge actually attained, the examiner would certainly give him credit for such higher knowledge. It would be easy, at any rate, in Chemistry and other subjects, to make a provision that should enable the examiner to accept evidence of actual original work; but I should be sorry to see it in any other than in the highest examination.

7883. (*Dr. Sharpey.*) The evidence of that original work might, I presume, be of work done previously outside the University altogether, because a man could not make a research in the University examination room?—He might give evidence of having made it. I think that all such work should be verified. I do not think that a man ought to be allowed to claim to have done work, to have gone through the anatomy, for instance, of an animal, and have made remarkable discoveries in the anatomy of that animal, unless the examiners are able in some way to verify it. I mean I do not think that that should be admitted as a qualification for graduation.

7884. Following up Professor Smith's inquiry, have you considered whether the practice, which is followed in Cambridge, of encouraging men to work in a particular line for obtaining high honours in the tripos examination, is favourable to independent thought or not?—I am not sufficiently acquainted with the subject to answer that question. I have seen the papers for the Science Tripos, and they seem to me very fair papers. I have seen the papers for the examination at Trinity lately, for the foundation scholarships; and I should say that they were papers very well framed



to bring out the candidate's general knowledge, and not at all the knowledge acquired in any particular groove.

7885. Do you think it would be practicable to introduce into the examination of the University of London, referring more particularly to the second examination for the bachelor of science, a practical examination in natural philosophy?—I have no doubt that it would be.

7886. Do you think it would be advantageous, supposing it were practicable?—At the second bachelor of science examination, as at present constituted, natural philosophy is treated mathematically only.

7887. I mean whether, between the first and second examination, the students might not advantageously work in a laboratory, and then show the results of that work at the second examination?—I think that would be extremely important. At present in neither examination is the candidate obliged to do laboratory work, in Chemistry, for the Bachelor of Science examination; he is for the scientific medical examination, but not for the bachelor of science; and I think that is a great defect.

7888. (*Professor Huxley.*) I apprehend that you would think of making the writing of a dissertation on some question involving some original investigation indispensable to the highest science degree in the University, as it is in some of the German Universities?—I think it might be so ultimately, but I should think it would be undesirable to insist upon it at present. Our whole scheme was framed tentatively, so to speak, because it was an entirely new subject on which to give the highest degree; but it may be as well to point out to the Commission that this degree is one quite unlimited in range,—I mean as regards elevation; it is limited in its area, but in regard to elevation and height of examination it is unlimited. The Senate desire to make it understood that a candidate for the degree of Doctor of Science will be expected to be fully conversant with the principal subject which he may select, so as to be able to go through any examination test, whether theoretical or practical, by which his acquirements in it can be fairly ascertained.

7889. I do not think you mentioned what had been the practical success of the science degree of the University of London. It was established how many years ago?—About ten or eleven years ago.

7890. Has the number of graduates been increasing?—There are always some for the degree of Doctor in science. Last year four passed, and four very good men they were.

7891. Is not the number for the lower degrees considerably greater?—Rather greater, but not any large increase.

7892. How many are there, on the average, for the Bachelor of science?—For the first bachelor of science about 35, I should say, is the average, but a large proportion, fully one half, of them fail.

7893. How many of them should you think take the degree of bachelor of science in a year, on the average?—About 94 have passed in nine years; the average number of candidates is now about 35, and the average number who pass is 15; so that out of 35, 20 have been rejected, and of those 20 a considerable number are of those men that I speak of who come up with a sort of *dilettanti* preparation.

7894. (*Chairman.*) Can you offer any suggestion to the Commission as to the means which might be adopted with a view to improving science instruction in schools?—I understand that the Endowed Schools' Commission is likely to introduce science teaching into a large proportion of the endowed schools: in some schools to make the curriculum of the school more especially scientific, and of modern knowledge; and in all schools, I believe, to introduce some amount of scientific teaching. I think that then the private schoolmasters will follow suit, and will feel it absolutely necessary to do the same; but I look to the influence of the Universities very much, as that which will bear upon the better class of private schools, when once it is known that the

rewards of the Universities are to be given as liberally to science as they are to classics and mathematics. I have no doubt whatever that all schools that prepare for the Universities would then make scientific culture a leading object.

7895. Do you think, that as a general rule, the appointments must be made with a special view to instruction in science, or do you think that in schools instruction of that kind could be satisfactorily given by those who teach in other subjects also?—I think that elementary instruction might be given by men who teach in other subjects. I have known extremely good instruction given by men who are professedly engaged in teaching other subjects; and I think that such men who have really studied the art of education will often teach elementary subjects better than a man of higher scientific culture who has less experience in teaching. I think that the knowledge of a boy's mind is a most important element in success in teaching; and the insight which a good mathematical master, for instance, will get into a boy's mind will help him very much in teaching natural philosophy, or even in teaching chemistry. What I think of very great importance is, to connect together the different departments of scientific teaching as much as possible. I think that the isolation of mathematics from the teaching of natural philosophy is a very great evil. I mean that the teaching of natural philosophy purely from the mathematical side is really very inefficient indeed,—it does no more good than teaching mathematics; and that for the same master to teach mathematics and natural philosophy, if the principle of natural philosophy is that it is to be taught objectively, is an advantage, because he will bring into his mathematics the objective ideas, and will connect them with the theoretical instruction. For example, I have known very good teachers teach trigonometry purely by formulæ. I have known lads brought up to know the algebraical relation between the sine, the tangent, and the radius, without having a notion of what the sine and the tangent meant geometrically. I think that that is a very great evil. The illustration applies to the relation of the two departments of mathematics. I have seen this constantly, that a lad learns arithmetic, and learns to square a number, and knows what a square number means; he learns to square them as a matter of arithmetic; but he has not the smallest idea of what a square means, or of the relation of similar figures being as the squares of their corresponding dimensions; and still more common is it to find that the relation of the cube is not in the least degree known in any other way than as an abstract idea,—the cubing the number, or the multiplying the number by itself, and by itself again. I am quite certain that a large number of boys never connect the notion of a cube number with the notion of a solid cube containing that cube number so many times of the unit. A good teacher, it seems to me, will connect the abstract ideas with the objective realities; and in that way there is an advantage in having the same teacher to teach the elementary parts of the two subjects; and a man who is accustomed to teach natural philosophy will, I think, be very likely to teach elementary chemistry well. I do not see the necessity of any great multiplication of teachers for the introduction of elementary science into schools.

7896. If greater encouragement were given to the study of science at the Universities, you think that the schools might provide for it without any very great increase in their teaching staff?—Yes, I think so. There are at the present time most excellent teachers of science at Oxford and Cambridge, among College Tutors, who obtained their fellowships by proficiency in classics and mathematics.

7897. Are there any other points upon which you would be able to furnish the Commission with any information as to your views in connexion with the University?—I have had occasion to know from Heads of Colleges, whose own teaching was classical, that they had observed a great improvement in the mental activity of many of their pupils after these pupils had

W. B. Carpenter, Esq.,  
M.D., F.R.S.

2 May 1871.



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applied themselves to the study of chemistry; and that they were frequently in the habit of recommending dull youths to go through a course of chemistry, for the purpose of calling out their general intelligence. I have already adverted to the great importance of encouragement being given in the Universities, by a fair distribution of the fellowships and other rewards of the Universities, to the study of Science. I think those distinctions might very well have reference to original work. I think that in the giving of fellowships, for instance, by the Colleges at Oxford and Cambridge, it would be a great stimulus to original work in Science, if it were known that such work would be recognised as a recommendation or a qualification for a fellowship.

7898. That has not been considered a requisite qualification at present, I believe?—At present, I believe, nothing but a man's acquirements are recognised. I am not aware that any evidence has ever been sought for of original research.

7899. A certain amount of encouragement has been given of late years to the study of natural science by appropriating scholarships and fellowships for proficiency in those branches?—Yes, and I am quite certain that it is exercising a most valuable influence.

The witness withdrew.

Rev. J. G.  
Cromwell, M.A.

The Rev. JOHN G. CROMWELL, M.A., Principal of St. Mark's College, Chelsea, and Honorary Canon of Durham, examined.

7903. (Chairman.) I believe you have been connected during a long period with Normal Colleges?—Yes. I was appointed to my first office at a normal College in the year 1849, in the College at Durham, and I remained there about 16 years. I became Principal of St. Mark's College about six years ago.

7904. Will you give us a short sketch of the history of St. Mark's College?—I propose to divide the history into three periods of 10 years each. It was founded in the year 1841, and during the first 10 years of its existence it received very little aid from Government. At that period a good deal of attention was paid to the teaching of classics, although mathematics commanded a fair share of attention, and a Wrangler of Cambridge was mathematical tutor. I do not think there was much attention paid to applied science. During that period the students who came into the college were scarcely sufficiently prepared to receive a very advanced kind of education; a proper teaching system in elementary schools had not come into operation. Candidates were generally admitted about the age of 16. They were picked boys from the national schools; the quickest and cleverest boys in those schools. Some of the students in that period distinguished themselves in various lines, and some of them have become clergymen. In the next period, between 1851 and 1861, there was a very great change, both in the amount of assistance that the Government gave and also in the character of the candidates who came for admission. The Minutes of 1846 began to tell upon the Colleges. Those Minutes provided for a system of apprenticeship to schoolmasters all over the country. The cleverest boys in the schools were selected to become pupil teachers. They received special instruction at the hands of masters, and for that instruction the masters were paid a certain sum by the Government. The result was, that the schoolmasters were stimulated to give as much instruction as they possibly could to their pupils, and the pupils came up to the College, in 1851 and subsequent years, with a very fair amount of mathematical knowledge. They came with a thorough knowledge of arithmetic in all its branches, applied as well as theoretical, with a knowledge of algebra as far as simple equations, and sometimes as far as quadratic equations, with a knowledge of the first two books of Euclid, as a necessary condition of admission, and very often they brought up four books of Euclid, and not unfrequently they came up with some knowledge of Latin. There was here a good foundation upon which subsequent knowledge could be built. Such were the

7900. You think that you already see some benefit as resulting from that?—I am certain that many young men have had their attention directed towards science, by the limited prospect which is held out of obtaining University distinction, and of substantial reward, by scientific ability. There has been a recent competition at Cambridge, and a very keen competition it was, for two scholarships in Trinity College. I know several young men who have been in that competition, and I am certain that their attention has been directed towards science in great part by the hope of obtaining University honours.

7901. Do you know how many candidates went in?—For the Trinity College foundation scholarships there were seven. It was not certain whether two scholarships would be given. At St. John's, for an exhibition of 50*l.* a year, 12 went in; but the competition for the Trinity foundation scholarships was limited to those who were already members of the University; while the exhibition at St. John's was one for which candidates might compete who had not been entered in any college.

7902. But they were required subsequently to enter St. John's, were they not?—Yes.

qualifications for admission into the College between the years 1851 and 1861; and during that time instruction was given in applied mechanics, in chemistry, in hydrostatics, and in optics. A laboratory was established, and a regularly paid and competent teacher was employed. Models of all the ordinary machines were bought, and the students were instructed in applied mechanics. Drawing was so taught as to be applied to the arts. The drawing master was an engineer of considerable experience, and a perfect enthusiast in the way of practical education. That was the state of things between the years 1851 and 1861; but in the year 1861, or thereabouts, a very great change took place. I ought, however, to mention one more point connected with that period. I should say that in the year 1854, at the representation, I think, of Canon Moseley, who was once Professor of Mathematics at King's College, special encouragement was given to the teaching of applied science in Normal Colleges by the establishment of lectureships for competent instructors, and those lectureships could not be obtained unless the lecturers passed a special examination before, I think, the Civil Service Commissioners. Every lecturer who did so pass (for instance, in chemistry, or in applied mechanics, or in any other subject of science), received 100*l.* a year from Government in addition to the salary which he received from the Council or Committee of his College. That grant gave a very great stimulus to scientific instruction in the various colleges. That 100*l.* a year was not paid, however, unless the lecturer continued to give satisfaction at the annual inspection of the College by one of Her Majesty's Inspectors. One of the Inspectors during a part of that period was Professor Moseley, and during the other part of that period Bishop Temple was Inspector.

7905. Did those lecturers lecture solely in the College, or could they lecture elsewhere?—Solely in the College, and it was a condition that they should have a fair salary from the college as well as the 100*l.* augmentation from the Government.

7906. Were they limited in number?—Yes, in proportion to the number of students in the College. A college of 30 could not have more than one lecturer, and a college of 100 not more than three lecturers.

7907. Will you now go on to the third period?—In the year 1861, a great change took place. The amount of instruction encouraged and paid for in the Training Colleges was very much reduced, and those lectureships to which I have referred were all of them



abolished. The Government has, for many years past, been in the habit of drawing up a Syllabus of the course of instruction to be followed in the various Training Colleges. That syllabus was very much curtailed in 1862. The special subjects, such as applied mechanics, physical science, and the higher mathematics, were all struck out, and the syllabus was reduced almost to the level that might be attained by a really clever boy in the first class of a good national school. The students were expected to have a certain amount of religious knowledge, geography, history, arithmetic, and two books of Euclid. At the same time, the amount of instruction given to pupil teachers all over the country was also diminished, because no longer were the masters and mistresses paid for giving instruction to pupil teachers, and the result was that in many cases scarcely any instruction has since been given. In most of the Normal Colleges, certainly at St. Mark's, and at Durham, where I was at the time, we struggled against that reduction in the subjects of the syllabus; we tried to retain the higher standard, as long as it was possible, with the students; we taught more things in the colleges than the Government required; but year by year we found that the pupils who came in were worse and worse prepared; so that at last it was almost impossible to give anything more than the Government syllabus demanded. I have a copy of that syllabus with me if the Commission should like to see it.

7908. What is the date of the syllabus?—The syllabus is almost the same that it has been since 1861. Under it the pupil teachers instead of being required to bring two books of Euclid into the college are only expected to bring up one book, and instead of being expected to go through simple equations, they are now not expected to have any knowledge of algebra; so that the whole standard everywhere, from the national school up to the training college, has been reduced in amount, making it extremely difficult for us to continue the higher style of education in the training colleges. The time given to the instruction of pupil teachers in each week was also reduced. Prior to 1861 the pupil teachers were to receive  $1\frac{1}{2}$  hours' instruction on five days in the week, or  $7\frac{1}{2}$  hours' instruction in each week; but subsequently to 1861 a pupil teacher was only required to have one hour a day or five hours a week. But time was not the only thing that was reduced, the teachers had not the same interest or zeal in the matter, because they were not any longer paid as before.

7909. (*Sir J. P. Kay-Shuttleworth.*) Might they not also be instructed in the evening school, if they so pleased?—Yes, that was another blow; the pupil teachers might be instructed in the evening school along with the ordinary scholars, and that almost reduced the instruction to the level of an ordinary evening school.

7910. Do you think that there were a good many teachers who took so very degraded a view of their duty as to teach the pupil teachers in the evening schools?—I am afraid that many did take that view. I think that the practice was also, to a certain extent, caused by the feeling on the part of the teachers that they had been very badly used by the Government. A very angry feeling was generated amongst the teachers by the withdrawal of the augmentation grant. Many teachers had passed the examination imposed by the Government under the distinct stipulation that they would have an augmentation to their salaries of from 20*l.* to 30*l.* a year, together with a special payment for instructing pupil teachers, and also many of them had been told that they would have pensions from the Government at the end of a specified term of service. All those promises were broken at once by the Government, and the result was that the teachers no longer felt the same zeal nor the same interest; many of them said that they felt themselves justified in not fulfilling their part of the contract, after the Government had so flagrantly violated its part. I would add, with respect to the period between 1861 and 1871, that when the South Kensington

scheme of examination became known, several of the Training Colleges, St. Mark's amongst others, determined, if possible, to stimulate their students, by proposing that they should go in for the special examinations. I went to St. Mark's in 1865, and in 1867 we sent in a small number of students in the subjects of chemistry, the higher mathematics, and applied mechanics, and we have continued to do something like that every year. We have sent in students every year since 1867 in two, and sometimes three or four subjects. I see, by an abstract which I made this morning, that in those four years, 1867, 1868, 1869, and 1870, we have passed 158 students through the examinations held by the Science and Art Department, who have obtained certificates of competency as teachers. A great many more have passed the examination, but 158 have passed so as to be able to teach the subjects.

7911. (*Professor Huxley.*) The certificate of capacity to teach now is reduced, is it not, to simply passing in the first class?—Lower than that.

7912. There was at one time a special examination, was there not?—There was; the certificate of competency to teach is now reduced to the second class: I should be very glad to see it made higher.

7913. Do you wish to see the special examination for teachers re-introduced?—Yes, very much; and if I were to give a reason, I should give this amongst others, that, latterly, the standard required for a certificate of capacity to teach, has not been high enough in the Science and Art Department. I could mention two examples that have come under my own notice: one of them was the case of a man who had obtained a certificate of a high class for teaching plane and solid geometry, and the other for chemistry. I proposed to employ each of those two men in teaching those subjects; but I found that they were incompetent to give instruction.

7914. (*Sir J. P. Kay-Shuttleworth.*) Who has given the instruction in subjects of natural science since the special teachers were withdrawn?—A former student of the College, who had been promoted to a post in the practising school, took the chemistry; our Vice-Principal, who was a Wrangler and a Fellow of St. John's College, Cambridge, took the higher mathematics and applied mechanics; in that way those subjects have been provided for; and, as I said, the drawing has been, until a very recent period, in the hands of a very able and enthusiastic teacher, Mr. Rawlins, who was a civil engineer, has had very great experience, and was extremely fond of turning every kind of drawing to practical purposes.

7915. (*Mr. Samuelson.*) Was he employed exclusively in your College?—No; during the first part of his engagement he practised his profession, latterly he did not. Some of his pupils have succeeded exceedingly well after having served for some years as schoolmasters.

7916. (*Chairman.*) Are the greater part of those whom you were speaking of just now as having passed the South Kensington examinations teachers in elementary schools?—Yes. Many of them also take special classes of an evening, and some of them are teachers in science schools. For example, one of them, whom I heard of only the other day, has been recently appointed a science teacher in one of the large schools connected with a manufactory in the Potteries.

7917. Will a reference to the Minutes in Council elucidate the variations in the system of the Training Colleges?—Yes; and it would show this, that a tolerably high standard of instruction was attained some 10 or 15 years ago, and, therefore, there is no reason, from the nature of the material that we have to work upon, why the same or a higher standard should not be attained again.\*

7918. You have stated that you have struggled, as far as possible, against the effects of the Revised Code;

\* The Syllabus of 1861 excluded the following subjects that had previously been required from students:—  
In the first year: mechanics, algebra, and Euclid, books III.



Rev. J. G.  
Cromwell, M.A.  
2 May 1871.

do you consider that, in spite of all your efforts, the effects of the Revised Code have been very marked in the character of the pupils that have come up to your Colleges?—Extremely marked, and never more so in our own case than in the course of late years, and for the very plain reason that, in the first two or three years after the Revised Code came into operation, we still were receiving into the College pupils who had been selected before that code came into existence; but after 1862 and 1863 the Inspectors of schools had scarcely any choice in the candidates who were presented to them. The parents of boys did not think that a schoolmaster's calling was a good one to follow; the Inspectors were obliged to accept anyone who offered, and the Training Colleges were obliged to accept almost anyone who knocked at the door for admission.

7919. The standard of instruction attained in the schools acts upon the standard given in the Normal Colleges in two ways, does it not?—Yes. A low standard prevents us from having so good a class of candidates sent into our Colleges, and the students when in the College have not any great interest in rising above the syllabus put before them by the Government, if they be not called upon to teach anything beyond the most elementary subjects in the schools. In former years, when more was taught in the elementary schools, a young man, anxious to get a good large town school well supplied with pupil teachers, felt that he must be prepared to teach all the subjects which the managers would want to be taught in such a school.

7920. Do very few go out now capable of teaching those extra branches?—Very few.

7921. Do you consider that a fair general education is essential as a preliminary to special instruction?—Quite so.

7922. Both for the scholars in a school and for the students in a college?—Yes.

7923. How should you describe the elements of a fair general education?—A candidate should be able to spell well, to write a fair hand, to work all the ordinary rules of arithmetic with accuracy and tolerable rapidity, and he should have some general acquaintance with geography and with history; otherwise, when he began his attendance at lectures in one of the special subjects of instruction, he would constantly find himself ignorant of subjects which ought to have been learned long before.

7924. (*Mr. Samuelson.*) What do you mean by special instruction?—Instruction in such subjects as chemistry, botany, mechanics, or the higher mathematics. It would be impossible for the college to teach those subjects now at once to all pupils, because they would not be equal to the work. You must be quite sure that your substratum is tolerably sound.

7925. But I think you referred also to scholars in a school. Do you think it would be necessary that children should all learn grammar before they received some instruction in the phenomena of nature?—No, I

do not mean that. I have an impression that grammar is of that abstract nature that it should be taught either later than other subjects.

7926. Do you think it necessary that they should be able to read fluently before they were taught natural science?—No; elementary instruction in natural science might be given at a very early age, dependent of course upon the skill of the teacher in selecting subjects, and on always giving that instruction in a concrete and never in an abstract form. A child will understand many of the laws of nature, if they are presented to him in a concrete form in connexion with something which he himself can handle, or see. That is one reason why, in my *précis*, I think, I have stated that I should suggest that physical geography should be taught in all schools.

7927. (*Chairman.*) Do I understand you that you consider that what you would term the general education is more defective now than it was before the passing of the Revised Code?—Yes.

7928. Even in the most elementary subjects of teaching?—No, I do not say that children do not read as correctly, but certainly not as expressively as formerly. I feel this, that their general intelligence is not awakened as much as before, because the instruction that they receive is confined so very much to the most elementary subjects, and the teaching is of a very mechanical character. It is so important now that children should pass the Government examination, that in some schools they are kept a whole year in working at some two or three rules of weights and measures. Those boys might probably, if it were not for the restriction, go on to one of the more advanced rules, and turn their knowledge of figures to some other form of applied arithmetic.

7929. Can you illustrate the alterations that have taken place in the system of instruction in St. Mark's College by extracts from the Minutes of Council at different periods?—To a certain extent I could, and also I could, by noticing the examination questions put by the Government Inspectors annually in the different subjects. Some subjects have dropped out entirely, as I stated in a former answer (7907).

7930. Can you give illustrations of the change that has taken place in the qualifications of pupil teachers under the inspection of schools before and after 1861?—Yes. The pupil teachers were before 1861 required to pass an annual examination before Her Majesty's Inspector, and if they did not pass they did not receive a certain sum of money from the Government, nor did the teacher receive the gratuity for giving Instruction. That being understood, it was possible to induce both the pupil teachers and the masters to work with a good deal of zeal, and to employ every hour that was allowed to them well, and the result was, as I said, that pupil teachers at the end of their course were expected to have a complete knowledge of arithmetic, theoretical and applied, an elementary knowledge of algebra as far as simple equations, two books of Euclid, a fair knowledge of mensuration, some knowledge of mechanics, and very frequently of Latin. Since 1861, one book of Euclid is sufficient; no algebra is required, and no Latin, and no mensuration, except of the most elementary kind. I think that describes pretty fairly the difference between the qualifications of the pupil teachers of the two periods. The difference in the inspection was of this nature, that before 1861 the Inspectors were called upon to inspect in all the subjects which were taught in a school; but after 1861, as a rule, they did not examine except in those subjects which were prescribed by the Code of 1861 and 1862—reading, writing, arithmetic, and some religious knowledge. That change caused the schoolmasters to cease from giving instruction in extra subjects.

7931. Is there any special remark which you would wish to make with reference to the school at King's Somborne?—That was a school in which a considerable amount of applied mathematics was taught, and the elements of chemistry as applied to agriculture. My reference to this was simply to show

and IV.; in the second year: logarithms, and the following alternative subjects:—

- (1.) Chemistry and the rudiments of electricity and galvanism.
- (2.) Euclid, book VI., algebra, trigonometry, simple machines.
- (3.) Three plays of Shakespeare, Bacon's Essays, History of Literature.
- (4.) Latin grammar and the knowledge of some Latin authors.

Previous to 1861 the third year's course embraced, besides a knowledge of Scripture, school management, vocal music, and drawing, one of the following subjects:—

- (1.) Mental science, as applied to education.
- (2.) Experimental science, especially as applied to manufactures and agriculture.
- (3.) Higher mathematics, including spherical trigonometry, the integral calculus, mechanics, and the course in Goodwin's "Mathematics."
- (4.) One of the following languages: Latin, Greek, German, and French.
- (5.) English history.
- (6.) English literature.

There is no third year's course in the present Syllabus.



how much was formerly done in some schools in the country in the way of giving elementary knowledge to children of even agricultural labourers in the subjects of arithmetic, mensuration, and agricultural chemistry.

7932. King's Somborne School was a strictly elementary school, was it not?—Eventually it became almost more, because the instruction was so good, as given by Dean Dawes, that the farmers began to send their children to it, and, therefore, he was enabled to keep boys rather longer than usual in an ordinary elementary school.

7933. Did it still continue a school for labourers' children, after it became a school for farmers' children?—Yes. The present Vice-Principal of St. Mark's College (as showing the way in which some of those boys have risen) himself was taught in that school at King's Somborne.

7934. The subjects that have been taught in St. Mark's College are very numerous, are they not?—Yes.

7935. Were they all taught at any one time just previous to 1861?—Not to the same students, of course; but I should say, looking over the list, that almost all were taught at the same time in the College—though not to the same students. The plan was this, a time-table was drawn up of the work for each week, and at certain lectures every student was expected to attend. Three or four times in the week the whole college was broken up and re-organised for the students to attend special classes according to their special qualifications. The Principal would take one section of the students in Latin, some one else would take another section in chemistry, and another Tutor would take some students in mechanics, and so on.

7936. Do you at present teach anything in addition to the subjects prescribed in the Government syllabus?—Yes; physical geography is taught to the whole of the students,—more advanced physical geography than the Government require. Animal physiology is taught to the whole of the students; plane and solid geometry and machine construction to a considerable number. What are called the higher mathematics, Latin, and French, are taught to a smaller number. I have one or two who are reading Greek with me: those men are anxious to pass the B.A. examination of the London University.

7937. (*Sir J. P. Kay-Shuttleworth.*) Would they be likely to devote themselves to elementary schools? Experience shows that many such men have done so for a time, and then have risen to higher posts. For example, two of the Tutors in the College now,—the Normal Master and the Mathematical Tutor of the College, are men sprung from the College, who have gone through the London B.A. examination, and are now following the business of teaching. One of our more recent students has followed precisely the same course, and is now the Vice-Principal at the Carmarthen Training College.

7938. (*Chairman.*) The College, I believe, possesses a laboratory?—Yes.

7939. Not solely a chemical laboratory?—No. Two or three years ago I obtained a grant from the Science and Art Department for the purchase of apparatus to give courses of lectures on heat and electricity.

7940. Do the students who make use of the laboratory do so mainly with a view to becoming teachers under the Science Department?—Yes; but not in elementary day schools, because there is no opening for that sort of instruction; they combine frequently two things; the master of an elementary day school often is the teacher of a science class in the evening, in London and in other large towns.

7941. Does the College also possess a supply of models for teaching mechanics?—Yes.

7942. And scientific apparatus of other kinds?—Not much else. There is a theodolite and other articles necessary for land surveying, but the apparatus is principally for teaching applied mechanics.

7943. The College is capable, in your opinion, of giving scientific instruction to a greater degree than it does at present?—Yes, I think so.

7944. What are the conditions which would enable it to give such instruction?—First of all, we must have duly qualified candidates for admission, and the standard of instruction and knowledge attained by such candidates must be higher than at present.

7945. Is the College entirely supplied by pupil teachers?—Not entirely; in different years the proportion varies, but 10 to 11 per cent. of those who come to us have not been pupil teachers. The education of such candidates is usually far worse than that of those who have been pupil teachers.

7946. Do they offer themselves, or are they selected by any process?—They offer themselves. It is perfectly free for anyone to offer himself for admission. If he passes the admission examination, and we are satisfied with his testimonials as to character, we then admit him.

7947. Must he declare that it is his intention to become a teacher?—Yes.

7948. All the students are there with the view of becoming teachers?—Yes.

7949. Not all in elementary schools, I believe?—Yes, the rule has been hitherto in elementary schools, that is to say, in a school under inspection; but the Commission are aware that a very great change in the meaning of the term "elementary school" has been made by the Act of last session. It now is made to embrace a much higher style of school, to embrace schools where the fee may be as much as 9d. a week.

7950. Will you proceed to state the other conditions which you consider are required to enable the College to give more scientific instruction?—The second condition that I thought of was, that there should be adequate encouragement again given to lecturers in colleges, or to the college itself to enable it to obtain the services of competent lecturers. I have not thought out the matter fully, whether it would be better to revert to the original plan pursued by the Government of giving the lecturers a certain fixed annual addition to their salary, or whether it might be given to the college upon condition that a certain number of students passed in the various subjects; but certainly additional encouragement should be given for additional instruction. I have said already that additional encouragement should be given to schoolmasters, for giving special instruction to their pupil teachers, because we find constantly that the classes in the college cannot go on with much advantage or satisfaction if the students have not had a sound elementary education given to them before they come to us. When, on the other hand, students have received a fair elementary education and a good grounding in arithmetic and mathematics, it is possible for the lecturer to go on with his whole class to a higher standard of information and knowledge. We find now and then a schoolmaster taking great interest in a pupil teacher; he so instructs his pupil that he is enabled almost directly he comes to us to pass the first examination of the South Kensington Department. I have a case of that sort this very week. A young man came up from Plymouth the other day, and his schoolmaster had taken so much pains with his education that he will be competent this month to go in and pass an examination which others will not pass for perhaps another year. That is what I mean by saying that further encouragement should be given, not only to colleges and lecturers in colleges, but also to schoolmasters. The third condition that I thought necessary for this object would be, that the Government, if possible, should reduce the amount of information required at present by the syllabus in the way of history and commercial geography. They require, in the first year, at present, that students should be prepared to answer questions in the whole outline of English history. It becomes to many young men both a weary matter and a very difficult matter to be prepared at all points in the whole range of English history, and to answer questions in nine or ten other subjects which claim their attention.

7951. Would you exclude it altogether?—No, not altogether; I merely say that it should be reduced in

Rev. J. G.  
Cromwell, M.A.  
2 May 1871.



Rev. J. G.  
Cromwell, M.A.  
2 May 1871.

amount. I do not think that it would be desirable that our schoolmasters should not be familiar with the great epochs in English history, but what I complain of is, the preparing of such a quantity of minute information which becomes very often simply a burden upon the memory. In the second year's course, the Government have for some years past adopted the plan of examining pupils only in a prescribed portion of English history, but the questions have often travelled far beyond the limits prescribed. I have before me some questions that have been proposed upon the portion of English history from the year 1789 to the year 1815. I take that as an example of one of those portions. I want to point out to the Commission some of the questions put upon this period, "Describe the growth of trial by jury?" "The growth of the national debt?" "What are the chief courts of law and equity, and where are they held?" "The growth of the East India Company and the events which led to its extinction?" The answers to these questions do not belong specially to the period between 1789 and 1815. The effect of giving such questions as these is very much like this, that the students either feel it useless to attempt to meet such papers and give up the subject in despair, or else they go to the other extreme of cramming their memories with all sorts of dates and facts in the hope that some of them may come into the paper.

7952. By whom are those examinations conducted?—By the Committee of Council on Education.

7953. Are they conducted in any degree by the Inspectors of schools, or are there Examiners specially appointed for the purpose?—There is some uncertainty on that point. I mean to say that I am not in a position to say exactly what it is, or how it is. Sometimes the Inspectors of elementary schools prepare papers, but whenever any complaint is made against a paper, the Education Department takes upon itself, as it says, the whole responsibility. I fancy that the papers, when they are set by Inspectors in the country, are afterwards revised in the Office, and the Office then becomes responsible.

7954. Are those same papers set to the students of all the Training Colleges?—Yes, the same papers are set to all Training Colleges everywhere, and the examinations are held at the same time all through the country.

7955. Are they part of the system of examinations under the Science and Art Department?—They are two departments under the same head. The Committee of Council has the Education Department at Whitehall under its control, and the Science and Art Department at South Kensington also.

7956. Are those examinations of which you are now speaking solely intended for students at the Training Colleges?—Yes. I was going to point out, also, that there is a similar fault, in my opinion, which I submit with great deference to the Education Department, in the questions in geography, especially in what is called commercial geography. Take, for example, such questions as the following: "What are the different kinds of sugar?" "What is the comparative commercial value of each? What is the history of the sugar trade?" and "What the history and the present government of Tasmania?" "Give the history of the cotton trade." Again, the effect is either that the students give up the subject in despair or else they cram it up.

7957. (Mr. Samuelson.) How are they supposed to get up those questions?—The Government seem to think that the lecturers ought to consult blue books, and to get the students to write down lengthy notes. Some of those points of course can be found in such Geographies as McCulloch's, but they are books of reference to which the students generally cannot have access; they have not time, in fact, to read them.

7958. Are the consequences of the students not being able to answer those questions serious to them?—If a man answers well, of course he gets more marks in his examination than if he answers badly. If he answers badly, he may get into the fourth class; if he

answers well, it may help him to get into the first class. But I think that everyone will agree that these are not questions which are calculated to improve the mental capacity, and test intellectual power. They are rather matters for exercising the memory. But, as long as such minute and whimsical questions in history and geography are proposed, we can scarcely find the time to give so much instruction in other subjects as we should wish.

7959. Have the Department ever offered any defence of this practice of entering so much into detail in those two subjects?—I do not think they have. I have mentioned the matter on various occasions, and the last year but one a memorandum which I presented to the Inspector was printed by him in the Blue Book. He made some comment upon it to the effect that very probably the syllabus would be shortly revised, and everybody was in great hopes it would have been revised this last January; but the syllabus that appears this year is almost the same as it was in former years, minus the religious instruction.

7960. (Chairman.) Does the probability of the student's obtaining an appointment depend a good deal upon the way in which he answers the questions set at those examinations?—Not of his obtaining an appointment, but of his obtaining a good appointment. The demand for teachers has been so great of late, that almost every student was sure of an appointment, and in one respect the Training Colleges have felt that to be rather an evil, because an indolent man had not the same amount of stimulus that he would have had otherwise.

7961. (Mr. Samuelson.) As regards the value of the appointments, would not the managers of elementary schools rather consult the Principals of the Training Colleges than pay attention simply to the class in which a man goes out?—Very often that is the case; but there are parts of the country (e.g. in large towns, and in large manufacturing villages) where the population is quite alive to the class which the master has won, and where a schoolmaster who goes with a low certificate would not command the respect of the neighbourhood; and sometimes the demand for a master with a high class certificate arises from the presence of competition. I sometimes have application made to me for a man of a particular class, because there is an opposition school within a mile where there is a schoolmaster holding a high certificate. "We must not have a man with a lower class," say the applicants.

7962. (Chairman.) Would you consider yourself justified in recommending a man who had passed in a lower class in preference to one who had passed in a higher class?—Yes, sometimes.

7963. You would not feel that you were at all bound by the result of the examinations in your recommendations?—Not entirely. Every year I select two or three students at the College for service in our large practising schools, and I do not always select a man from the first class, but I choose him because he has some special qualification together with the general qualification. If I want a man to teach drawing, I select a good draughtsman.

7964. Have you also some suggestion to make with reference to the return to the system of paying grants for third year's students of special subjects?—My idea is, that there might be a demand for teachers for a class of school above the ordinary elementary school. If, under the operation of the Act of last session, a far higher class of teachers were required, then it seems to me that the present two year's course would not be sufficient. I should be very glad to see the subjects of instruction, both in the first and the second year, of a higher nature than hitherto, but also I think that it would be desirable that third years' men should be allowed to study special subjects and receive special instruction in the College, or if the College is not capable of giving that special instruction, then out of the College.

7965. (Mr. Samuelson.) How long do the men remain with you?—Two years. At the end of each



year they have to pass a prescribed examination, and if a man does not pass the examination at the end of the first year he has to go over the course again.

7966. When was the third year's course suppressed?—I think either in 1861 or 1862 the Government declined to make any grant on account of third year's students, and, of course, the Colleges are not able to afford to maintain a student after the Government grant is withdrawn.

7967. (*Chairman.*) The withdrawal of the instruction necessarily followed on the withdrawal of the grant?—Yes. The whole system of payment was altered. Some of the grants were withdrawn, and others reduced in amount.

7968. Would you consider that the third year's students would be specially fitted to become teachers of science under the Science Department in the country?—It seems to me that they might be so prepared, because in every batch of young men you will find that one or other has got some special liking for scientific subjects; and those men would no doubt be able to follow up the study so as to become competent science teachers. They might follow out any subject to which they had shown a preference in the second year, and so become competent teachers for really superior secondary schools.

7969. (*Sir J. P. Kay-Shuttleworth.*) If a superior department were attached to elementary schools, a schoolmaster who had had a third year's training would be competent to conduct such a school as that?—Exactly so. Such men are very much wanted at times, and I cannot lay my hand upon them now.

7970. (*Chairman.*) Are you asked to recommend such men?—Yes, frequently.

7971. (*Mr. Samuelson.*) For elementary schools?—No, not exactly for elementary schools. They are wanted for what are called lower middle-class schools.

7972. (*Chairman.*) Are you of opinion that the education of masters for primary and secondary schools could be carried on satisfactorily in the same college?—Yes, I think there would be a great advantage in it. I believe it would induce a different class of candidates to come forward to claim admission into the Training Colleges. A youth of good ability might hope that if he succeeded well in his first and second year's course, he might have an opportunity of passing into the third year's course, and might at the end of that third year's course take service in a good secondary school, instead of having to pass, as at present, through the lower elementary schools of the country. Many who would hope to do that, might not be able to do it. But the very fact that you induced young men of superior parentage and nurture to come into college, would, I think, be a distinct advantage. Any boy who had superior ability would be brought into notice, and I fancy that it would do good in other ways in the college. We should have a better tone in many respects, although I do not complain at all of that now, because the pupil teachers are very carefully selected as a whole; but I mean to say there would be a more refined tone; for the fact that a portion of the students were aiming at a higher standard, would lift up, to a certain extent, the energies of the whole of the college. Therefore, I think, it would be an advantage to the secondary schools,—for they would get a greater number of teachers competent to give instruction,—and I believe it would be an advantage also to the teachers of the lower primary schools. The curriculum for the two classes would be the same in the first two years; the difference would be in the third year's course.

7973. With regard to the secondary schools which you have in your mind, do they exist to any extent at present, or are they rather prospective?—Not to a large extent, but they do exist to an appreciable extent.

7974. (*Mr. Samuelson.*) Do you include private adventure schools?—No. I have a great many applications from private adventure schools, but I do not think of providing for them, although they often have urged and do urge their claims very strongly, and remonstrate very much. They think it is a very hard

thing that the Government object to give any kind of assistance to adventure schools. I believe, that there is scarcely any want in this country greater than that of competent and respectable ushers for private adventure schools.

7975. Would there be any objection to the Training Colleges giving instruction to young men preparing themselves for that profession on payment of somewhat higher fees?—The objection would be probably of this kind—the Government might object if any portion of the buildings of a college to which they had contributed a building grant, were occupied by such a class of students. I could just imagine that they might make that objection; and also the other great contributor to the college, that is, the National Society, might make a similar objection.

7976. (*Sir J. P. Kay-Shuttleworth.*) Speaking of Training Colleges, are they so limited in extent as not to be able to prepare a sufficient number of masters for the present elementary schools?—Yes, we could not supply more than we do at present, unless we trained students for one year only; we do not fully supply the present demand.

7977. (*Mr. Samuelson.*) Taking your own College, are all your rooms occupied?—At present every one. Last year we had a considerable influx, and a greater influx still last January. That was of course owing to the prospect of an increased demand for schoolmasters. The parents of young men are keenly alive to their prospects.

7978. Was it the case, that there was a great falling off in the number of entries, so much so that many of your rooms were vacant after 1861?—Yes, a great many. It was a steady going down of the tide, dropping every year from 1863, till at last, in the spring of 1869, instead of having 50 or 60 candidates for admission, we had, I think, only 34, and the College, instead of having 104 inmates, had less than 80 inmates.

7979. (*Sir J. P. Kay-Shuttleworth.*) Can you enumerate the Training Colleges that have been shut up in consequence?—The Highbury Training College and the Chichester Training College were entirely closed, and the Colleges at Chester, York, Durham, Culham, Peterborough, and Exeter were scarcely half full. It was the case almost all over the country. The number of pupil teachers fell from 13,000 to 6,000.

7980. (*Mr. Samuelson.*) Do you attribute the revival in any manner to the encouragement which was given by the payment for extra subjects, two or three years ago?—No; that payment for extra subjects scarcely amounted to anything that could be appreciated. The payment was never to exceed 8*l.* in any school, and an additional pupil teacher was usually required, so that the additional grant for extra subjects did not meet the additional outlay required.

7981. (*Sir J. P. Kay-Shuttleworth.*) Was not the Minute very complicated in its conditions and exceedingly difficult to understand?—Yes, very complicated, and sometimes excellence in one section of a school caused the loss of the grant, because another section failed to reach an equal standard of excellence. There was to be a uniform excellence over the school, and if certain classes passed a better examination than some others, the grant was lost.

7982. (*Chairman.*) Will you be so good as to enumerate the subjects of a scientific nature which you consider suitable, in the first place, to primary schools, and, in the second place, to secondary schools?—Understanding by primary schools those in which boys are generally under 13 years of age and above seven, I know by experience that the elements of physical geography can be very well taught almost throughout the school. The first step in geography should be made in physical geography, and one advantage possessed by this subject from an educational point of view is this, that almost everything in it can be presented to a child in a concrete form. He may learn something about the principles of heat, about air and water, about natural history, and the action of the elements upon the surface of the globe. He can have illustrations of those things pointed out to him in his own

*Rev. J. G. Cromwell, M.A.*  
2 May 1871.



*Rev. J. G. Cremona, M.A.*

2 May 1871.

neighbourhood almost, wherever he is. It seems to me that it is the best introduction to any knowledge of physics that might be hereafter required. Wherever the teacher had a special bent for chemistry he might illustrate what he had to say about the laws of physical geography by his knowledge of chemistry. If, again, he were a man who took great interest in natural history or botany he would dwell more upon those portions of the subject. Physical geography connects itself with almost the whole circle of what are called the physical sciences. I know that children and young men also take great interest in the subject, and what they take great interest in, they learn quickly. We pass twice as many students through the physical geography examination at South Kensington as in any other subject. Another great advantage is, that it does not require any complicated or expensive apparatus. It is of all scientific subjects, as it seems to me, the very best for an elementary school.

7983. (*Sir J. P. Kay-Shuttleworth.*) Have you not also observed a great benefit to arise from the logical connexion that you can give to instruction in such a subject, as, for example, taking the drainage of England and showing the distribution of the population?—Yes; a teacher may take a good map, and, placing it before his class, he may lead his scholars to find out the reason why certain towns have grown up at certain points; he may lead them to trace the influence of winds and currents upon climate, of climate upon vegetation, of vegetation upon animal life, and so on. You can get children to draw many conclusions for themselves: for instance, why the people in Yorkshire and in Lancashire are chiefly manufacturers, and in other parts of England agriculturists.

7984. (*Chairman.*) Does the Revised Code give any encouragement to the study of physical geography?—I am glad to say that the Revised Code is at an end. We have a New Code now which gives encouragement to physical geography, algebra, geometry, physics, and languages. Another subject which I find can be generally taught in the upper classes of an elementary school is Drawing; it is very useful, because, as we all know, many boys go from the elementary school to various building trades, or designing trades, where knowledge of drawing is of the very greatest importance to a boy who wishes to rise in the office or in the yard. Some boys from our practising schools are now in engineers' and machinists' offices, and are likely to do very well in the world. I should like also to have mensuration taught generally. A great deal of time is taken up in working sums in vulgar fractions, practice, and weights and measures, some of which weights and measures never come into common use. The arithmetic of an elementary school should be very practical.

7985. You think also that a certain amount of information in natural science could be given in elementary schools?—A certain amount of an elementary character, remembering that it must always be given in a concrete shape, with plenty of illustrations. For example, experiments can be exhibited to children illustrating the properties of heat, by taking a common bladder and putting it before the fire, and showing how the bladder fills and bursts, or by taking a bar of iron and putting it into the fire and heating it. Such common experiments are things which boys can easily comprehend. In the same manner, I think, they should be familiar with some of the simple machines and instruments, which could be explained to them by ordinary models, and they should know something about the common properties of matter; something about the different forms of attraction—chemical attraction, capillary attraction, and so forth. All this would be useful to boys of almost all classes, whether in town or country.

7986. What additional subjects would you think desirable in secondary schools?—Boys who were likely to stay at school till they were 15, could be taught, I conceive, some knowledge of geometry (not sticking too close to Euclid), algebra, applied mechanics, physi-

ology, the laws of health, and, perhaps, of chemistry, where special facilities exist, and where there is a fair laboratory. I do not suppose that all these subjects could be taught well in the same school to the same pupils. One set of boys, probably, would have a liking for one of those subjects, and capacity for learning it, and another set of boys a capacity for learning other of those subjects. I venture to suggest another reason why we must not attempt to take up these subjects all at once, because in secondary schools the general education ought to continue to go on; and I have found, in the practising schools connected with St. Mark's College, that many pupils, even boys who are to go to trade, are most anxious to learn, at least, one foreign language. In order, however, to learn French, a boy must give many hours a week to French. We find, in the practising schools at St. Mark's, that the parents are most anxious that their boys should learn French, and many of them wish that they should also learn Latin. Two or three years ago I felt that, perhaps, we might give up Latin and give more time to other subjects. Before, however, making the change, which was a very important one, I asked the Head Master to inquire of the lads' parents whether they were willing that the subject should be dropped; the general reply was, "No, they hoped that Latin would still be continued," and so we continue to teach Latin in the upper school. Some boys remain long enough to be able to read Cæsar; a much larger number of boys remain long enough to read French tolerably well, such as the books of Erckmann-Chatrian. The knowledge of a foreign language is greatly valued, as it gives to boys the chance of good employment in some of the various firms and offices that trade with the continent. We have a French master in the school as well as an English master who takes the younger pupils. The French master comes twice a week to see to the reading and pronunciation of French.

7987. Do you contemplate that Latin will generally be included in the curriculum of the lower secondary schools?—No, I do not think so. I do not think, if I were to begin now, I should be disposed to introduce it. It takes a good deal of time, and only a certain proportion of the boys ever attain much facility in reading it. Still, I find advantages in it, for boys are sometimes sent to us who are intended to become chemists, surgeons, or lawyers.

7988. (*Mr. Samuelson.*) What are the fees in the upper department of your school?—They vary, but the highest fee is 25s. per term, and there are three terms in the year. In the lower portion of that school, the fee is only 15s. per term.

7989. Does 25s. include all the extra subjects?—Yes.

7990. (*Chairman.*) You are now speaking of schools connected with St. Mark's College, not of St. Mark's College proper, not the Training College?—I am now speaking of the Upper Practising School connected with the College.

7991. I see among the subjects that were formerly taught at St. Mark's College, Greek is included, what class of pupils thought it worth while to learn Greek at the College?—When the College was first established, the fee was 25*l.* a year for every student, and there was a feeling at that time that it was desirable that the schoolmasters should be deacons, and with a view, therefore, to prepare them for the position of deacon schoolmasters, Greek was taught. A small portion of those young men have become clergymen. The number was very limited; I think, between 1841 and 1851, the number who became clergymen was not more than 30. In 1851, when the Government grants were increased, a different style of instruction was given, and Greek did not come in as a prominent subject: of those men, however, very many have been teachers, in grammar schools—one of them has become one of Her Majesty's Inspectors—and several of them have become Principals of Training Colleges, or Vice-Principals, so that they have done good service to the cause of elementary education.



Rev. J. G.  
Cromwell, M.A.

2 May 1871.

7992. (*Mr. Samuelson.*) What is the sum that St. Mark's College receives annually from the Government?—Something under 4,000*l.*, it varies in each year, but it has not of late years reached 4,000*l.*, 3,800*l.* or 3,700*l.* has been about the amount.

7993. The average number of students, I think, you say, has been 100?—Yes, a little under 100.

7994. So that that would be something over 40*l.* per head?—Yes, there is a limit that it shall never exceed 50*l.* per head, but, as a matter of fact, it very seldom exceeds 40*l.* per head.

7995. What are your other sources of income?—A slight fee paid by the students on admission, which raises about 250*l.* a year, and an annual grant from the National Society of 800*l.*; also, we have some private subscriptions.

7996. (*Sir J. P. Kay-Shuttleworth.*) You have already said that the students are lodged and boarded in St. Mark's College?—Yes.

7997. Will you state to the Commission whether you see considerable moral advantages to be derived from the training which the students get under the eye of the Principal by the adoption of that system?—Yes. I think very great advantages, as the result has tolerably well proved. The general conduct of the students who have left the College has been highly satisfactory. I send at stated periods a letter of inquiry to the various employers throughout the country, to ascertain how our students are going on, and whether they are giving thorough satisfaction, and I am glad to say, that, with very few exceptions, indeed, their conduct is eminently satisfactory.

7998. Supposing that pupil teachers came to London, at the age of 18 or 19, or even at a somewhat later age, and were not lodged at a Training College, but in a suburb of London, what effect do you think that would have upon the morals and life of the students?—I should be disposed to think not a salutary one: in some of the suburbs there are quite as many temptations as in the very centre of London.

7999. Do you not feel that in the system which exists at present of training students for two years under your own eye, you become the centre of a corporate system, and exercise a great power over the students after they leave you, whilst they are doing their duty in life?—Yes, I quite feel that. I am constantly receiving letters asking my advice and opinion upon various steps that those men take in after life, and I endeavour to follow out the history of each man, and each man in that manner feels he has a character to maintain, and he very often, I believe, retains a great amount of affection, sometimes for one and sometimes for another of his old Tutors in the College, and for the College itself.

8000. Is it not your experience, and that of almost every Principal, that one of the duties which engrosses a large part of his time is keeping up that correspondence with absent pupils?—Yes, it demands both time and thought.

8001. Probably you have the satisfaction of feeling that, by the maintenance of this correspondence, you influence their lives for good?—I hope so.

8002. Let me suppose that a body of young men were to come up to London to attend a Training College for any subjects of instruction, elementary or scientific, and they were not lodged and boarded as these students at St. Mark's are, and not subject to the kind of moral discipline which is maintained over them at St. Mark's, would you not fear that a very considerable portion of the students placed in such a position in London might go astray?—I think it is very likely they would not have that *esprit de corps* which I think at present exists among our students.

8003. Let me take the case of a young man well qualified to succeed in scientific studies, having a natural capacity, and some previous means of applying himself to science, that he needed a certain time for the completion of his instruction and for acquiring a knowledge of the method of conducting a scientific class with the greatest skill, would you prefer to

place him as a lodger in London, or to place him in a Training College, such as that which you conduct?—I should prefer certainly to place him in a Training College, because there is a great deal of education derived, as it were, incidentally by association with others who are more or less competent to give instruction and example. There is a great deal of mutual instruction really given, especially in that matter of the art of teaching, because we are careful to devote a considerable amount of time to the business and method of teaching under the superintendence of the Normal Master, whose whole time is devoted to that work, and to lessons given by one of the students in the presence of his fellow students. The criticism of his fellow students is often more felt than the criticism of any one else. That result would not be felt, because the students would be to a certain extent strangers to each other, if they were not lodging in the same building.

8004. If, therefore, the Government desire to have a body of elementary or somewhat superior scientific teachers prepared, you would prefer that that should be accomplished either by adding a third year's training in St. Mark's, or by the adoption of some similar system in a special College?—Yes, I think so.

8005. To what extent do you consider the same application to the art of teaching and the science of method to be required for teachers of science as is required for teachers in elementary schools?—The same general principles, as it seems to me, ought to be followed with reference to each particular subject, but if instruction is to be given successfully in that, as in other subjects, it seems to me that the teachers should be prepared for their work under the eyes of more experienced teachers, who should point out faults of method, and so gradually teach the young teacher how he can best convey his information.

8006. In the absence of any other method, a young man who had gone through an ordinary apprenticeship in an elementary school and had spent his two years in a Training College, would be more capable of seeing, and feeling for himself, the way to give scientific instruction than if he had not had the ordinary training in method which he would acquire in those two spheres?—I feel quite certain of it, and that comes out very strongly, indeed, in the difference observed between those students in the College who have been pupil teachers, and those who have not been pupil teachers. We require every student to go into the practising schools to teach a class of boys, and also to teach a class in the presence of the rest of the students, and no one, even the utmost stranger, would fail to notice a difference between the way in which a young man who has been a pupil teacher manages a class, and that in which it is managed by another young man who has not been a pupil teacher. The pupil teachers' course, therefore, is extremely valuable as a means of suggesting the right method of class-teaching.

8007. There is a third method which might somewhat interfere with the discipline, and produce complications in a College, and I would ask what would be your impression with respect to it. It has been suggested that there might be a class of students under the discipline of such a College as St. Mark's, and receiving a certain amount of instruction there, but who might attend a purely scientific school, for example, at South Kensington, or elsewhere in London, and proceed to laboratories and classes at that school, returning to St. Mark's at night—would you state what you think about that?—That idea presented itself to my own mind sometime ago, and I do not see any serious disadvantages in it; of course, the Principal would have to exercise his own discretion as to the men to whom those privileges were given; but, with the class of men that I generally have, I should have no hesitation in allowing them to attend any lectures in the morning or afternoon of any day, but I should rather hesitate to give them permission to go out in the evening. Our rule is, that everybody is to be within the College walls before 7 o'clock. Certainly,



Rev. J. G.  
Cresswell, M.A.

2 May 1871.

the advantage is obvious of having special lectures by men specially qualified in each subject.

8008. In fact, under the present system, the amount of trouble which you have, on moral grounds, amongst the class of students, both whilst they are in residence and after they have left the College, is very small?—Very small, indeed. We have now on the staff tutors who have themselves been students in the College, and who state that the students, as a body, have been particularly pure in every way.

8009. As another test of the effect of the present system of training, in its greater degree of efficiency, looking back to the time at which you would consider that you received the largest amount of encouragement from the Government—when St. Mark's was in its best condition—will you give the Commission the impression which you have as to the effect of the training upon the habits of young men as students, and their desire to enlarge their knowledge, and to obtain a higher degree of intellectual cultivation in after life?—That has manifested itself in various ways. Many of them, after they have left the College, have continued their studies, and have been able to pass the London University examinations. Many of them have risen a little above the rank of national schoolmasters; some of them have given special attention to the subject of music, for example, and have passed the examinations of the University of Oxford. Very recently, two of our students have taken the degree of Bachelor of Music in the University of Oxford.

8010. It is within my own knowledge that the Secretary to the Educational Department of one of the largest English Colonies, the Heads of two Colleges in India, and the Head of a large Training College in one of the Colonies, were actually pauper boys before they were taken into the Training College, and have won those positions by their subsequent efforts in self-instruction. Can you point to any examples of a similar character?—I have stated, incidentally, that one of the former students of St. Mark's is one of Her Majesty's Inspectors of Schools. I can hardly say how many have become Principals or Vice-Principals of Training Colleges; several of them have held very important educational appointments in the various Colonies, and a large number of them have attained to the best situations in elementary schools and in grammar schools.

8011. Taking a master who would be trained under the very limited system which has recently been the result of the Revised Code, and a master such as St. Mark's College would have produced at the period of its greatest efficiency, which of those two masters would you think would have the most beneficial influence upon a purely elementary school, and have the largest amount of success in purely elementary subjects?—I should have no doubt in saying that the man who had been trained in the former period rather than in the latter, as a rule.

8012. Then your opinion is, that it is a mischievous notion that masters, under the best condition of St. Mark's College, were too highly trained?—I think so. I think it was a mistake. I should say, in passing, that I think due attention was sometimes not paid to the business of teaching, inasmuch as there was rather a high pressure put on too many of the highest subjects, and, therefore, perhaps, not quite so much time or attention was always given in the practising schools—perhaps not quite so much as might be desired now.

8013. But, if proper attention were given to everything that is taught in the practising schools, to the art of teaching, you would have not only no objection, but you would highly appreciate that better instruction which was given in the most flourishing part of the history of St. Mark's College?—Certainly.

8014. (Mr. Samuelson.) I think I understood you to say that the demand for elementary teachers is decidedly on the increase?—Yes.

8015. Supposing a school of science, the object of which should be to train teachers in science, were established in London by the Government, and that it

were expected that the teachers would attend that school after they had completed their course in a Training School like yours, do you think that, taking into account the demand which exists now for elementary teachers, you would induce men to attend a special science school after having completed their course in a training school; whether the fact of such a school being in existence would cause it to be visited, seeing that there is now a large demand for elementary schoolmasters who could at once obtain employment?—Those men who can forego present gain for the sake of future advantage would attend such a school, but those men whose parents and friends look for immediate advantage would, of course, prefer immediate employment.

8016. From what you know of the character of the men and of their relations, do you think that the number would be large who would be prepared to forego the advantage of immediate employment?—Not very large, certainly, because a certain amount of self-denial must be exercised on the part of themselves and their friends; their support in college does not relieve them, of course, from certain expenses in the vacations; so that there would never be a large number, if they were of the same class as we have at present.

8017. In such a school as I am speaking of, the pupils would have to support themselves, except in so far as they might receive some assistance from the Government.—Then that would make the number still smaller, because the men that we have spring from a class whose friends can do very little for them, indeed.

8018. You think that the number would be small, even if they were boarded, and the number would be smaller if they had to maintain themselves either wholly or partially?—Yes; I should like to add that my impression is this, that the demand for teachers now is exceptionally high, and in a few years' time the supply and demand will be more equal.

8019. How do you expect that to be brought about?—The loss of teachers per cent. is but small, being under seven per cent.; therefore, as soon as schools are once supplied, it will not be difficult to maintain a sufficient supply from the existing colleges, or with the aid of a very few additional ones.

8020. But in order that they may be once supplied, would it not be necessary that the number should be nearly doubled, or even more than doubled?—I am not prepared to say that. I do not know whether I should be right in expressing an opinion here as to one way in which the number of teachers might be rapidly increased. There are many young men, who were trained as pupil teachers, now acting as ordinary copying clerks, and receiving very small salaries. During the last year, I received applications from one and another of those men, asking me to assist them to become teachers again, owing to the altered prospects of a teacher's calling. If the Government were to announce that they would hold a special examination for such persons who are in many ways excellently qualified, having passed through the pupil teacher's course, they would immediately have, I am satisfied, hundreds, if not thousands, of applicants, who would be competent to fill many of the smaller schools.

8021. Are you now speaking of those men who have abandoned the career of teachers, and who would return to it?—Yes; many who have deserted it under the cloud would come back to it under the sunshine.

8022. Are the pupils at St. Mark's College drawn from any special area?—No, we have them from Scotland, we have them from Cornwall, and from all parts of the country.

8023. But is it not the case, that the students in country colleges are drawn generally from the area immediately surrounding them?—Much more so. When I was at Durham, for example, the great majority belonged to the four or six northern counties. A good many came from Lancashire, but certainly the four northern counties were the principal feeders.



8024. If you believe that your pupils would with difficulty be induced to enter the Government School of Science in London, would not you expect that there would be still greater difficulties in inducing the pupils of the provincial colleges to enter a school in or near London?—Yes, I am afraid so.

8025. If the teaching of science were encouraged in the metropolitan and provincial Training Colleges, have you any doubt that you will be able to train good elementary science teachers?—I have no doubt of it.

8026. I speak of the provincial colleges as well as of yours?—I have this feeling that the Metropolitan Colleges would have a decided advantage over the Provincial Training Colleges, owing to their students having access to such schools as the School of Chemistry in Oxford Street, or the School of Mines in Jermyn Street, or the lectures at South Kensington.

8027. That is to say, the establishment of similar schools throughout the country would be a great advantage to the pupils of the Provincial Training Colleges?—Certainly, the same kind of advantage which we derived from the establishment of schools of design in the country. I was in the north when schools of design were first established, and when such a school was proposed in Durham, I assisted very cordially in establishing it, because I saw that directly we got a school of design there, the students of the College would have the advantage of instruction by special teachers. The same thing might occur again in the case of the establishment of science schools in different parts of the country.

The witness withdrew.

Adjourned to Friday next at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Friday, 5th May 1871.

PRESENT:

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.  
Sir JAMES PHILLIPS KAY-SHUTTEWORTH, Bart.  
BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.  
THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

The Rev. JAMES HARRISON RIGG, D.D. examined.

8032. (*Chairman.*) You are Principal of the Wesleyan Training College, Westminster?—I am.

8033. Will you be so good as to describe to the Commission what it has been found practicable to do in that College in the way of imparting instruction in science to the students?—Perhaps I may say that advantage was taken, soon after founding the College, that is to say, in the year 1856, of an opportunity to purchase scientific apparatus—about 200*l.* was spent in purchasing scientific apparatus for the College at that time. A lecture room, 30 feet by 25 feet, was fitted up for the reception and use of this apparatus. It included a good supply of articles and material for the teaching of inorganic and organic chemistry, and also for the illustration of the chief phenomena and principles of practical mechanics, hydrostatics and hydraulics, pneumatics, optics, and heat, frictional and galvanic electricity, and magnetism. The College also is equipped with a supply of maps and diagrams illustrative of animal physiology, physical geography, and geology. Pure and mixed mathematics have always been taught to some extent in the College, and, up to 1862, to an extent about equal to that required for the B.A. degree of the London University. Mr. Sugden, the Head Master, has given instruction in chemistry and natural philosophy from the establishment of the College in 1851; and Mr. Mansford, mathematical instruction for the greater part of that time. During the last three or four years, other three of our teachers, who, as well as the two former gentlemen,

8028. You would consider it in the interests of the education of elementary science teachers to encourage the establishment of schools of science in the provinces rather than to attempt to bring all those men up to London?—In the interests of elementary scientific education, I decidedly think so.

8029. You would consider that such a College situated in London would tend to become not really a National College, but a London College?—I think it would tend to become that.

8030. (*Chairman.*) Do you think that a large portion of the instruction now given under the regulations of the Science Department could be given in elementary schools as part of their regular work?—I scarcely think that much could be given in the form in which it is required by the Science Department. The South Kensington system is (of course it is quite capable of defence), that the student who comes up for examination should have a tolerably accurate acquaintance with the subject or subjects in which he professes to be examined. For instance, if he takes up the subject of optics he must study it thoroughly; he is not supposed to have any knowledge of other subjects. It seems to me that, in an elementary school, we shall have to give the teachers and pupils an elementary and popular knowledge of more than one of the physical sciences.

8031. Are there any other points upon which you could furnish the Commission with information?—I think I have had a very full opportunity of saying all that I wanted to say.

are University graduates, and are registered as science teachers by the Department of Science and Art, have given instruction in physical geography, animal physiology, and chemistry. What has actually been accomplished has varied considerably at different times. Some discouragement took place at one particular period, and, perhaps, I had better say how the work has proceeded or varied from the beginning. From the beginning of our work we laid down the principle that the children in our elementary schools ought to receive information on various points of science, which at that time were not generally taught in the school reading books, and, therefore, that could only be done by oral lessons, what we call oral secular lessons, and it was also thought that it was much better that it should be done by oral lessons. Those were given several times weekly by the principal teacher of the school. Our object was to train the teachers who should be competent to become the principal teachers of schools to give such lessons several times a week as a regular part of the instruction of elementary schools. Those lessons were given to the whole of the children seated in a properly constructed gallery; the system of gallery collective instruction by such lessons being one of the leading features in our method. The subjects of those object lessons, which provided for the incidental introduction of the students to the knowledge of what may be called scientific facts, were such as these: the structure and habits of remarkable

Rev. J. G.  
Cromwell, M.A.

2 May 1871.

Rev. J. H.  
Rigg, D.D.

5 May 1871.



Rev. J. H.  
Rigg, D.D.

5 May 1871.

animals and plants, short explanations of various scientific principles involved in manufacturing processes, as, for instance, the construction of some common machines, involving, of course, the principles of mechanics. All those were taught as they might best be taught to children, together with points in physiology, as bearing especially upon the preservation of health, instruction with regard to our own body and its organs, the atmosphere, and other such topics. The teachers prepared lists of topics suited to the different classes of children, according to their age, according partly to their grade in society, and also according, in some instances, to the neighbourhood in which they live, as, for instance, particular topics for schools in seaport towns, and other topics suitable for schools in manufacturing districts, such as the pottery districts, and so on. I may say that the list of such lessons, which is given in Mr. Stow's "Training System," the 10th edition, page 430, was a list prepared by Mr. Bailey, one of our teachers, and accepted by Mr. Stow. This was our scheme from the beginning, and in the early history of our Training College, that is, from 1851 to 1862, this was very systematically carried out. The scientific instruction was intended mainly to qualify the teachers to give such lessons with good effect; but besides that, a limited class, usually about one-half of the second year's male students, who showed particular aptitude for science, received some sort of systematic instruction in the elements of physics, and the other half in mathematics. A paper on these subjects was at that time always given by the Committee of Council for the second year's examination at Christmas, and that was the case up to the year 1862. In 1862 that paper was discontinued, which, of course, operated to the discouragement of scientific studies and training at the College. Our Head Master, Mr. Sugden, notwithstanding, continued to give to all the male students an abridged course of instruction both in inorganic chemistry and animal physiology, in connexion with the paper set, after that date, under the title "economy." I should say that some of the students who had taken the Christmas paper in physical science up to 1862, which was at that time an alternative paper, and a few others subsequently, also passed the science examination of the Board of Trade, at the time when science was under the cognizance of the Board of Trade, and, after 1859, of the Department of Science and Art; but the stimulus given to scientific study by the Department of Science and Art was only just coming into operation about the year 1861. However, in 1868, 1869, and 1870, the encouragement given by the Science and Art Department had begun to tell so powerfully, that instruction was fully restored in those subjects, and some classes of the students were presented for the May examinations of the Department of Science and Art, and there will be a large number of them this year. The subjects selected for such examinations were physical geography, inorganic chemistry, elementary mathematics, and, in part, theoretical mechanics, and this year animal physiology. Those were preferred, as being in some relation to the ordinary course of training prescribed by the Committee of Council on Education. The female students attempted nothing more than physical geography. Of course, that includes some instruction about the habitats of plants, and about geology, and so forth. Some of the male students took four subjects, but the majority of them took only three, and the results are shown in our Report for 1870, page 99.

8034. The elementary instruction in the day schools, which you were speaking of, continued, as I understand, between the years 1862 and 1867?—Yes, it was never given up, but there is no doubt that from 1862 everything suffered; our infant school processes suffered, and everything suffered more or less, perhaps, owing as much to panic as to anything else; but many things were sacrificed in, I do not say the majority, but in a considerable proportion of our schools, to what were considered to be paying results.

8035. Have any arrangements suggested themselves to you which would tend to make the instruction in

science more comprehensive and efficient?—Perhaps I may refer to the syllabus as it respects female students first, and then the male students. We think that something might be done, more than has been done, in the way of giving female students some elementary instruction in science, and our idea is, that, with regard to domestic economy, the systematic study of domestic economy might be limited to the first year, that if the female students went through a course of domestic economy in the first year, in the second year they might have reminders of it, but that a regular course of domestic economy for one year would probably be sufficient, and, in that case, in the second year, there might be substituted for the course of domestic economy some such work as Dr. Lankester's "School Manual of Health," or Professor Huxley's "Lessons in Elementary Physiology," and that it would be very desirable if something of that kind were introduced into the course for our female students. We fancy that that is as much as probably could be done with advantage in the way of introducing our female students to scientific subjects, and as much as they could very well use in their schools; but as for the male students we think that more change might with advantage be made. For instance, in the first year, under the head of "grammar," as it stands now, questions are set on the Latin accidence. Latin is not really a ponderable element in our course at all. No extension of those lessons in the Latin accidence is asked for in the second year, they are exceedingly elementary in the first year, and if they are only to be given to so very elementary an extent in the first year and to be dropped in the second, we think that something more valuable might be done; that it would be better either to make language in itself a real instrument by such a development of it as would be an intellectual discipline, taking the first and second years together, or else to make something else to be the real instrument of improvement. Our idea is, that instead of those elementary and altogether rudimentary lessons, which fade from the memory inevitably, especially in the course of the hard study of other things, because the other things in the course of the next year entirely grind out all the evanescent impressions that were produced by those rudimentary lessons, it would be better to put in probably a little science, and prepare in the first year for science in the second year; at all events, we think that in the syllabus there is a waste of power and time. Then, again, there is a head in the syllabus entitled "economy," which, for the first year, is by no means defined. It is stated under that head that "elementary questions in sanitary, mechanical, and other practical science of common application" will be set. There is no idea given as to what sort of questions will be set under the head of economy, and year by year our tutors try to guess at what possibly may, under the head of economy, be subjects on which examination questions will be set. It is the purest hap-hazard, and the result is that they almost cease to make any attempt at preparation for that particular subject. For instance, one of the questions recently set under the head of economy related to "the recovery of persons apparently drowned." Of course, one could not have anticipated beforehand that that would form any part of the course of collegiate instruction. Another was to give a "description of the tools required to make the furniture of a house." Our whole staff think that it would be better, if, instead of that vague and altogether nondescriptive head of "economy," there were really something of a progressive and substantive character given in which to prepare the students, and that, of course, would place some time and some power at the disposal of the College for science work. I may say, as partly bearing upon the same topic, that the syllabus does not recognize algebra at all, which, perhaps, is a mistake. I am not, of course, called upon to give an opinion, but whilst the syllabus does not recognise algebra, algebra is required to be understood by students of the second year as far as quadratic equations, in order merely to the solution of certain



arithmetical problems. The consequence is, that the students find themselves expected to solve questions involving quadratic equations, although they have never had any examination questions at all involving the elements of algebra, and although algebra forms no part of the syllabus, either of the first or second year; there is no examination whatever in the rudimentary processes, whether the first four rules or surds, or anything of that kind, nor even in simple equations, but at once they are required to possess a knowledge of quadratic equations in order to solve some problems with regard to the rules of arithmetic. Here, again, we think that either algebra should be made a real subject of study, in which case unquestionably it might be very valuable, and the students might be conducted in accordance with the requirements of the syllabus up to quadratic equations, or that it should be dropped entirely out of the course. By some re-arrangement of this kind we fancy that a good deal might be gained in the way of improving the present syllabus, and finding time for giving instruction in science to our students. We think that, besides inorganic chemistry and the elements of mechanics, an elementary knowledge of animal physiology might be provided for in the second year at any rate.

8036. Has the syllabus been unaltered now for some years?—I think in its essential particulars it has. I have only myself been three years at the College, and many of these details are new to me. Perhaps, I should say that, besides an elementary knowledge of physiology, we think that a regular outline of inorganic chemistry, instead of the fragmentary instruction of occasional lessons, might be given by properly husbanding the time, and that if a regular outline of instruction in inorganic chemistry, as far as the elementary stage of the Department of Science and Art, were given in the first year, and then an elementary knowledge of animal physiology, and the advanced stage of inorganic chemistry, were given in the second year, the combination of the two would be exceedingly valuable.

8037. Are we to understand that the syllabus generally influences the course of instruction provided in the College?—It ought to define it.

8038. And it is intended that it should so define it?—Yes.

8039. Have any representations ever been made as to the defects which you consider to exist in the syllabus?—I believe that no official representations upon the subject have ever been made. It has been a matter of frequent conversation when the Inspectors have visited the College year by year, and I believe that the Inspectors, so far as I can speak from my own knowledge, have always agreed with the general view that we have taken, but the Committee of the College have never made any deliberate representations upon the subject to the Committee of Council.

8040. (*Sir J. P. Kay-Shuttleworth.*) Are you aware whether, after the Inspectors have had an opportunity of ascertaining the views of the Professors and Principals of the Colleges, they are invited to any consultative conference as to the syllabus in the Educational Department?—My belief is that they are not so invited, and that any opportunity that they have arises from personal intimacy or from special causes.

8041. (*Chairman.*) At what age do the students usually come to you?—At 18 usually; that is the minimum; that is to say, it is possible that they may enter our College a few months younger than 18, having passed through the five years' pupil teachership, but, speaking generally, the minimum age is 18. The pupil teacher candidates, in the large majority of cases, enter at the age of 18, because they are usually apprenticed at the age of 13 for five years. The voluntary candidates, who have not been pupil teachers, frequently enter at a considerably later age. We have some now at the age of 26, and upwards.

8042. Have you many voluntary students, those who are not pupil teachers?—Yes. My impression is that we have about 12 per cent., one year with another, of voluntary candidates.

8043. (*Sir J. P. Kay-Shuttleworth.*) They would be selected from the knowledge that you have of the zeal and talent of young men who are employed as teachers in your Sunday Schools in the Wesleyan Connection?—Yes, very much from that. We have made it known that we value the element exceedingly in our College, and our Ministers are aware of that, and when they meet with a young man, or a young woman, who seems to be fond of teaching, and who has anything like a capability of being trained within two or three years, they will sometimes give them instruction for 12 months, or get it given to them, until they can come up and pass the Queen's Scholarship examination at Christmas, and then they will come in for two years. Many of them have been discovered, and many of them have found out their own vocation, in our Sunday Schools; in the first instance, I should think, most of them.

8044. (*Chairman.*) Your course consists of two years, does it not?—Yes.

8045. Do you think that any advantages would arise from providing a special course of instruction for a third year for students who had developed a special aptitude for the study of science?—I think there would be a very great advantage in a third year's instruction, but it is another question how far that third year's instruction could be given in the College. It appears that a third year's instruction must be of the highest possible value for any who have a peculiar aptitude for giving instruction in science, and, as the first two years must be given very mainly to acquiring the general knowledge proper to the profession, therefore there can be very little surplus time for the development of any aptitude that they may possess in the way of scientific knowledge in the course of two years, whereas, if they had got the requisite preparation in other respects during those two years, that third year might be given very largely to the development of their scientific powers and aptitudes, and to furnishing them with the requisite knowledge, but the question would be whether so many of them in any one college could be discovered as would make it desirable to retain them in that college. It will be seen at once that a third year's course must involve a considerable addition to the number of the staff, and to the number of the classes. Therefore, if there is to be a third year's course at all, supposing, for instance, that there were, we will say, in any college, 50 students the first year and 50 the second, it is a loose economy not to have 50 also in the third; but if, having 50 the first and 50 the second, you could not expect to have more than 15 in the third, then to have a third year's course in our institution, would not in itself be an economical thing. And, therefore, it has occurred to us, when talking this over, that, whilst it is of very great value to have a third year's course for students, it is a point to be considered whether that third year's course would not better be furnished by some general scientific college to which many students from different colleges might repair, where there might be a purely scientific staff provided, and where everything might be adapted to making science not, I think, the only but the predominant matter of instruction. Of course, a difficulty would arise, and the difficulty would be as to taking charge of those students, because any such central scientific institution for the third year's students would not be upon the same basis of management as any one of the constituent colleges that furnished its quota. I do not know whether it might not be quite practicable to retain in the College the students under the charge of the Principal and generally speaking of the staff, whilst they repaired at given hours to this central institution. I am not at all sure that some such arrangement might not be made by which they should remain in the College, which is exceedingly desirable, if it could be accomplished, and yet at the same time repair to the central institution, but the subject is difficult. The only thing that seems clear is, that if scientific teachers of high quality are to be provided for the country, there must be a third year's training.

*Rev. J. H. Rigg, D.D.*

5 May 1871.



Rev. J. H.  
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5 May 1871.

8046. (*Sir J. P. Kay-Shuttleworth.*) I think I perceive that you have two objects in view: one is the moral discipline secured by residence within the College, and by the arrangements for the supervision of the conduct of the students, which you would extend to scientific students, and the other question of economy, so that you might have from 15 to 25 or 50 without greatly deranging the teaching staff of the College?—Yes, those two objects certainly, and I think a third, namely, that if you have selected students of eminently scientific aptitudes, it is probably desirable to secure a style and quality of apparatus and scientific provision and instruction which you could much better secure by one institution, of the kind that I speak of, than you could find anything equivalent for such an advanced class of students in their respective and separate colleges, because, of course, those students would always be more or less an exception—you never could tell how many you would have in any individual College, and you could hardly afford, therefore, to sacrifice the general training of the first two years to the exceptional provision of the third year, and the cost would be very great to get teachers of the requisite accomplishments, which could hardly be afforded if you were only to have a few students. Consequently, it appears to me that, not only for economy and moral supervision, but for real scientific efficiency and provision of every kind, it is very well worth looking at whether it could not be done in that way.

8047. Some extension of the buildings of your College would be necessary for the collegiate management of this new class of students, provided the same number of students remain in the first and second years' classes?—Yes, clearly. In fact, we have too large a demand upon us as it is, and that demand is multiplying; it is not simply growing by addition, but by multiplication. The whole question of enlargement becomes important under any aspect of the case, but if a third year's course were to be added it would become increasingly urgent upon us.

4048. I understand you to say that you do not anticipate that the Education Committee of the Wesleyan Conference would be averse from meeting any desire of the Government in the direction of the provision of high scientific training for this third class of students by some such expedient?—I have no doubt that they would be very glad, indeed, to do it if they could see their way to it. Of course, this is a very large subject. We may, perhaps, have to enlarge our existing accommodation for students. I have no doubt that any extension that we might make would be in the way of having for ourselves a second College, and separating the sexes; that we should retain the College where I am as a male College, and we should have to obtain, for training the female students, a College somewhere else. If, however, a third year's course were to be added, it would be absolutely necessary, besides that, to enlarge the existing College in Horseferry Road.

8049. (*Professor Huxley.*) To put a hypothetical question—supposing that the Government should establish a Science College at South Kensington, at which practical instruction in elementary science could be given to such persons as you have under your superintendence, namely, the future masters of elementary schools, do you think that your students would take advantage of that instruction in the manner which has been just discussed between Sir James Shuttleworth and yourself?—I think they could as third year's students.

8050. (*Sir J. P. Kay-Shuttleworth.*) Would your own experience, and the traditions of the College, justify me in the conclusion that the consequences of the moral training of the pupil teachers and the students in the College have been such as to secure for you a very large amount of success in the good conduct of the students in their future lives?—As to that there cannot be two opinions. The number of cases of anything like going wrong, whether at the College or afterwards, has been singularly small; wonderfully small, I may say, in connexion with our College, because we have young people of both sexes under the

same roof; at present about 70 of each sex. It is not what I would advise; there are advantages in it, but there are a great many difficulties connected with it. I only mention that, to show that, from the moral power that has been obtained over the students in the course of their pupil teachership, and from their very careful selection, and the moral discipline exercised over them, I do not think at all harshly, the College has hitherto been successful in a very eminent degree in the point about which you inquire.

8051. Looking to the experience which your whole Wesleyan Connexion has of the effect of the apprenticeship and of the two years' training upon the character and conduct of the students, do you think that your body would regard with much favour the project of sending young men up to London to lodge without that corporate supervision which is given by the Training College to attend purely scientific classes at a central institution?—I cannot imagine that anyone who knows young people, that anyone who has seen in them, virtuous young people as they are, the susceptibilities which are natural to them, who knows what it is to be transferred from country life to town life, and from home to lodgings, and who knows the feeling of a stranger in London streets, would regard it as desirable and expedient under any circumstances for young people between the ages of 18 and 21 to be taken in large numbers to London with a view to their living in lodgings and attending at a central institution. I have looked at that matter again and again, I have examined the subject, and conversed about it, and I confess that I have not yet found any person, whatever his opinions may be, who thinks that that will be a practicable plan.

8052. You are not only willing to co-operate with any plan that might be devised for a central institution for high scientific instruction for the third year students, by applying the machinery of your College co-ordinately with that central institution, but you would be averse from any plan which did not connect with the scientific instruction of a central institution similar moral training and discipline to that which exists in your College?—When I say that I should be in favour of that connexion with the central institution of which I have been speaking, I should like it to be understood that I am simply representing my own individual opinions, as this question has never been before our Committee in any form whatever. These are my opinions. Of course, I recognise the thing as a thing which is to be done, and which ought to be done, if you are to provide the necessary teachers for the nation; and if it is to be done, though there may be some hazard or difficulty about the way of doing it, it must be done in the best way possible, and, to me, it seems that the way which has been indicated is the best way; but if I were asked what I should think of a proposal to remove those students at the age of 20 from under the discipline and care of our collegiate institution to send them into lodgings, I should say not only that it would be a very expensive mode, but that it would infallibly lead to the wreck of a great many of those young people. They have not had the battle of life and the discipline of life, and without attributing to them any vice or sin that might not be forgiven by those who knew their circumstances, they would simply be weakened and broken down, on the one side and on the other, if they were to be exposed to such an ordeal. I may be wrong, but that is my opinion.

8053. (*Professor Smith.*) You have said that your students would be able, owing to the situation of your College, while remaining a third year in your College, nevertheless to receive instruction at a central school of science, if such an one should be established by the Government. Could you inform us what is the number of training colleges similarly situated with your own, that is to say, how many other training colleges in London would, owing to their position, be able to avail themselves of it?—Supposing that South Kensington were the centre (I do not know whether I am right in assuming that), then, although Sir James



Shuttleworth knows the Colleges better than I do, I would say that Battersea, St. Mark's, Whitelands, the two colleges connected with the Borough Road, and our own could all attend, because it is within a walking distance for the young people. Homerton could not, but Homerton College only contains about 40 students, I think. I speak without accurate knowledge, but I think it only contains about 40 students.

8054. At any rate, as many as six or seven colleges could avail themselves of South Kensington?—Yes. As for the Home and Colonial I do not think they could; that, of course, is an institution for mistresses, and I do not think they could. Highbury is given up, I think. The Home and Colonial of course could manage it at a certain outlay by means of the Metropolitan Railway, and, probably, Homerton also, by the trains from Broad Street. There are other situations which might be more central. If any provision could be made for such an institution as I have spoken of at Charing Cross, it would, especially with the help of the boats, be more accessible. It would be equally convenient for the colleges that lie west, and it would be more convenient for the Borough Road and for the Home and Colonial, which would come down there directly.

8055. (*Chairman.*) Would you contemplate that those third year students would take charge of the ordinary elementary schools, or would they not be trained beyond what was required for that purpose?—I think so. It appears to me that if a third year's training is to be bestowed upon students in this way, it really would be altogether overdoing it, if they are to be employed in ordinary juvenile schools. I may, perhaps, take this opportunity of saying that there was a proposal, some years ago, for a third year's training, and that at St. Mark's they carried it out for years, but it failed because the third year's students did not find a natural sphere and adequate payment in any of the schools that were open to them. If students are to be induced to remain a third year, they must be sure of a much higher salary when they leave at the third year's end, otherwise they will not be induced to stay a third year. They must be sure, not only of a higher salary, but, speaking generally, of a superior status in society, because when they have been five years pupil teachers, and two years in training, they are very eager, and naturally very eager, to get into life and do something for themselves, and you would not induce them to remain three years unless they were certain that they would have a higher sphere in which to teach, a better status socially, and a better salary. I can conceive that there might be science schools; that is to say, in many of the centres of England, there might be schools for teaching science to boys, and girls possibly in some instances, but certainly to boys, who have developed a scientific aptitude, and that those teachers, trained a third year, would provide a corps of scientific teachers and trainers, and I venture also to think that there is nothing that requires training in teaching more than scientific instruction. Of men of science there are many, but of men of science who can teach science there are comparatively few, and if it is difficult to develop high teaching faculty in ordinary subjects, I cannot help thinking that when it comes to making matters of science clear and evident to very young people, a man of scientific knowledge ought to have received a special training as a teacher, and if we could combine scientific attainments with all that modern art has taught in the way of training to teach, we should have results in the development of scientific knowledge, and power on the part of our population incalculably superior to anything that we have as yet any idea of.

8056. (*Sir J. P. Kay-Shuttleworth.*) Are you aware that the third year's course at St. Mark's College was connected, in its origin, with a then prevalent wish on the part of certain portions of the church to connect the function of a teacher with the deaconate in the church?—I was not aware of that.

8057. (*Chairman.*) Do you see any field beginning to open itself for the employment of students such as

we have last been speaking of?—I have heard it in conversation, and seen intimations of it otherwise, that the Science and Art Department, which has begun this course in London, Dublin, and elsewhere, has it in contemplation to promote the setting up of schools of special scientific instruction, as far as possible, all over England, but, at all events, in the large centres, and if that were to be the case the difficulty for them would be to find teachers. If there were teachers trained a third year in the way indicated, a supply of teachers for such schools would be found in that way.

8058. Have you ever thought that such a system might ultimately supersede the present arrangements under the Science and Art Department?—The present arrangements under the Science and Art Department I imagine are preliminary and tentative. I do not know what the supersession could mean, unless it were that the Science and Art Department was to be finally merged in some great Educational Department, of which science should be a branch, otherwise I imagine that the Science and Art Department must go on rather to develop than to diminish.

8059. I rather meant, that what was done now imperfectly might be done better under a system of science schools generally established throughout the country?—I think in order to carry out what appears to be the object of the Science and Art Department, to make it at all practicable, some such system of schools and of pupil teachers would be necessary.

8060. (*Sir J. P. Kay-Shuttleworth.*) What is your opinion as to the influence of the previous preparation during the apprenticeship, and the first and second years' training in the College, in giving a knowledge of the art of teaching. Would this skill develop in the third year's instruction of a purely scientific character, and increase the power of teaching science in these students?—The suggestions with regard to the improvement of scientific instruction for the first and second years, which were spoken about at the commencement, would of course have a direct bearing upon making the instruction for the third year thoroughly efficient. Of course, scientific aptitudes are special endowments, and such scientific aptitudes would be discovered by thoroughly intelligent teachers who had received a good first and second years' training, even though they might not have received a third; they would have received enough scientific knowledge to be able, when they are in their schools, to elicit and to recognise scientific aptitudes on the part of their scholars. That being the case, they might be employed, if once the system were widely diffused, as, so to speak, the caterers for the higher class of science schools. Boys and girls, perhaps, might thus be found who would naturally be indicated as proper scholars to be got into these schools. The course to be given in those schools where there are children, many of them of working men, is another question, but it appears to me that a thorough scientific instruction, so far as it is possible, for the first two years, of student-teachers in the Training College, would have a very important influence in enabling them to discover in the ordinary elementary schools the children who would be proper to go at the age perhaps of 13 to 16 into the science schools, which children, in the science schools, would afterwards be taught by teachers of the same class, but only of a higher grade, who have been three years under training, and in that way the whole system would complete itself.

8061. What I also want to know is this: What class of teachers do you think would be most likely to be efficient, two of which I will describe; the one a class of teachers who, having had no previous training like that of the apprenticeship and the training college, went simply to a science school with whatever advantages of instruction in the art of teaching they could obtain there, and the other a class of teachers who, from their early life went through the apprenticeship and the training college, and then had superadded to that the training of a science college. Would you expect the first or the second class to be the most efficient?—I should think, as to that, there really could not be

*Rev. J. H. Rigg, D.D.*

5 May 1871.



Rev. J. H.  
Ragg, D.D.

5 May 1871.

two opinions. Teaching is an art which is not to be acquired thoroughly in the course of a year, and when, in that year, you have both to acquire the art of teaching and to acquire possession of the matter that is to be taught, the difficulty of getting the whole thing accomplished in one year must be very great, but if the teachers had been regularly trained as pupil teachers and had been two years at the College, and had also acquired a perfect command and a sort of instinctive command of all that belongs to the proper mode of instruction, little more is requisite for them afterwards than to have the matter of instruction given to them; they have already acquired the art of teaching whatever they know, all of which goes upon certain principles which have been thoroughly worked into them, and, therefore, I suppose there cannot be any doubt at all as to the immense superiority of those who have been thoroughly trained from the beginning, and who are proved to have had themselves equal aptitudes from the beginning with others for the acquisition of science.

8062. (*Professor Huxley.*) Looking to the development of elementary education in the country in future, and to the probable extensive introduction of science teaching into elementary schools, will not that react upon the training colleges in this way, that the pupil teachers that come up to be trained will already come provided with a very considerable amount of elementary scientific knowledge, which now they have to acquire, and that, therefore, it may be possible to give them that further instruction in the mode of teaching science even in their second year?—I think it very evident that if the College syllabus were duly adjusted, then, under a system of instruction, one of the recognized objects of which was to give scientific instruction in elementary schools from the very beginning, and, as far as possible, to elicit scientific aptitude, pupil teachers would come up vastly better prepared, and that by the close of their two years' course, many of them would already be thoroughly respectable and efficient scientific teachers. But I think it doubtful whether the average of them would possess so much scientific knowledge as would be proper to put them in charge of schools of science for boys of from 13 to 16 years of age, because it appears to me that they ought to have a great deal of clear knowledge in order to that.

8063. Would it be possible, without taking up too much of their time in the second year, to let them go to this hypothetical science college and to receive lessons in practical science there?—I think not; at present they are so severely tasked that if they had both to give their time there, and the time to go there and back, I do not think it would be at all possible.

8064. There is an alternative which suggests itself, namely, the introduction of science teaching by specially qualified teachers into the colleges themselves, by some arrangement with the Government; that would, of course, involve the setting up of a proper laboratory in each college, would that be a less expensive method in the colleges themselves, or a more practicable method than the students staying over a third year?—I do not know how far, under severe pressure, it might be possible to secure the time, but my own feeling at present is, that the pressure is too severe upon the students, that it does not allow them to do anything more than pursue the straight line of their preparation. You find many very intelligent and able students who have just read whatever they were obliged to read during the five years, and have just gone through their lessons, but who have never read a book through that could be called a real classic in their lives, and I think that anything that puts severer pressure upon them would be apt to make that very undesirable characteristic of teachers take a sharper edge. My own feeling is, that, at present, they have not time enough, and if they had more leisure, so that they might not only do their work, but occasionally read a book for themselves, they would have far more, I was going to say, of modesty (but that is really not my meaning); they would have far more knowledge of themselves, and of the things

round about them. Taking up a certain limited line which they felt they were compelled to do, they have no idea of the depths of knowledge right and left, and sometimes, upon a certain number of subjects, they make foolish mistakes, although they may be capital teachers, and, therefore, I should deprecate taking up more time in the way of routine than is taken up at present. I do not think you can carry the system much further than what I have indicated.

8065. There is another method by which schoolmasters, having a knowledge of teaching already, can be trained in scientific method, and that is, that after they have undergone their work, and attained the age of manhood, and become responsible persons, with some experience of life, it is possible, during a few months, to give them very efficient discipline, that is to say, by bringing them up to London and paying their expenses for a few months, and letting them work hard at their special science training during that time. Do you see any great practical inconvenience about that plan?—I have thought of that plan, and I think that Professor Huxley will at once perceive that there will only be a very few who had a sort of passionate and insuperable instinct after science learning and science teaching who would ever come up under those circumstances. Teachers, as a rule, marry by the time they have been a few years in the profession, and I do not think it is desirable to alter that state of things, and for them to give up a school which is affording to them, generally speaking, a very good competency, if they have anything in them, and to come up to London for three months, which involves the necessity of a 12 months' interval, as they are only engaged from 12 months to 12 months, involves the abandonment of the school where they now are for an uncertain opportunity and an uncertain chance. Just as we sometimes find that men will give up grocery in order that they may go into the law, because they have developed a certain talent for the law, and feel perfectly certain that if they only had a chance they would get on, and so they article themselves, and fag hard for a few years, so there would be cases of that kind; but I do not think that if the object is to make a large national provision that you would get that done.

8066. Perhaps, you are aware that the Science and Art Department this year is pursuing, on a further scale, a method of this kind, that is to say, notice was given some months ago that teachers in elementary schools, where teachers of science were connected with elementary schools, might, if they pleased, under certain conditions, come up to London for six weeks during the summer, and there work at a process of training of this kind; their expenses are paid, and, therefore, it costs them nothing. As a matter of fact, the number of applications to come up were exceedingly numerous, and it was necessary to limit them by a process of examination, because nothing like the number that applied could possibly have been accommodated. I do not know whether that arises out of the comparative shortness of the period, but I mention the fact to show that for a six weeks' training, at any rate, that particular objection does not apply?—I was not aware of that. I am very much interested to hear it. I should think that the shortness of the time must have something to do with it, they must have got a supply for the time being which could not generally be done. They have got the leave of their Committee, and have taken it at the time when there was a holiday besides. Of course, if it were possible, by such an experiment as this, to procure that, the thing might be done in the way that you indicate; I think it would be the solution of a difficulty.

8067. I see, from the syllabus of the year 1856-57, that practical instruction in physical science was recognised, and, indeed, there was a very excellent notice, I perceive, that no training college shall be allowed to present candidates for examination in this subject (physical science) if the Inspector reports that the institution is without sufficient apparatus to give experimental instruction?—Yes, that was so then, under



the influence of Canon Moseley and Dr. Temple and others.

8068. Was that system broken down by the Revised Code?—Yes.

8069. Do you think that that system might be introduced with advantage on, perhaps, rather a better scale?—I think that the principle of that system might and ought to be re-introduced.

8070. Do I understand you that at the present time the children in the Wesleyan schools receive lessons in elementary science as part of their regular instruction?—Yes.

8071. How many lessons a week do they have?—I explained that we started with the idea that they should receive about three lessons a week. I said also that many of our schools have suffered from the effect of the Revised Code, but, notwithstanding, that our best schools still keep up that system.

8072. (*Professor Smith.*) Is the syllabus to which you have referred several times issued by the Committee of Council on Education?—Yes.

8073. If it should be thought desirable to introduce science more largely than at present into the education given at the training colleges or in connexion with them, it would become necessary that this syllabus should be revised, would it not?—I think so, clearly.

8074. And that revision would fall upon the Committee of Council on Education?—Yes.

8075. Would you look with perfect confidence or the reverse, considering the circumstances of the case, to the syllabus that would be prepared under those circumstances?—My impression is, that the Education Department of the Committee of Council might do a little more in gathering the judgment and the experience of those who have actually been employed in the various training colleges in order to the revising of their syllabus. It seems clear to me that it is desirable that they should have the opinions both of Inspectors and likewise of those who are themselves in the work, and that they ought not to attempt any revision except after having carefully gathered such opinions. At present, I think they are not in the habit of attempting to do so.

8076. Are they, on the other hand, in the habit of taking the advice of any scientific persons?—I really am not aware. I believe that Mr. Cowie has a great deal to do with arranging the syllabus, but I do not know at all on what rules the Education Department acts.

8077. With regard to the syllabus of scientific instruction, do not you think it would be desirable that it should be prepared in such a manner as to inspire confidence, both in the scientific world and in the great body of teachers?—Clearly, I think that is very essential, and I can imagine also that the Education Department would look to the Department of Science and Art for suggestions upon a matter of that kind, and would derive great benefit from their suggestions; but, at the same time, I do not feel very competent to speak upon these matters. I only say that I do not gather from our own experience that there is any attempt to ascertain what we find out with regard to the working of this syllabus, and I do not gather that the Inspectors have any constitutional opportunity necessarily afforded to them of giving the results of their inspection upon those heads.

8078. (*Chairman.*) Have you any model school connected with your College?—We have connected with our College five schools; one of those is called a model school, but is only a model school in a very special sense. We may say that we have two model departments, that we have what we consider a model department for a large town with a great population, and that we have a model school which is intended to be an image of what a village school might be. The model department consists of an infants' school and a juvenile school for children between the ages of 7 and 9 or 10, and two senior schools, one a boys' school and the other a girls' school. That we consider to be a model establishment for a large town, but then, as many of our teachers have to go into

villages, it would not do for them to receive only that kind of instruction which what might be called a graded institution of that sort would afford them, and, therefore, upon the principle that people often send their boys to be apprenticed in a general shop in a village that they may learn all branches of a business, so we have a model school which includes children of both sexes and of all ages above seven, and that is intended to show our students what sort of school they will actually meet with if they go to teach in a village. In this way we try to give them two model establishments, one for a village, which is one school, and the other for a town, which consists of four.

8079. (*Professor Huxley.*) Is there an infant school connected with your Training College?—Yes. The infant school, of course, serves to prepare for the village model school as well, but it has its place in immediate connection with what might be called the model arrangements for a large town, an infants' school, a juvenile school, and two senior schools, one being a boys' school and the other a girls' school, the juvenile school being mixed. Although our mixed schools go up to the age of 9 or 10, they do not go beyond that, except in the case of the model school, and that is mixed for all ages. We call it a model school, simply as a model of a village school.

8080. (*Chairman.*) I think you stated, a little while ago, that in some of your best schools, notwithstanding the influence of the Revised Code, you are able to keep up a considerable amount of scientific teaching. How did you manage to counteract the influence of the Revised Code?—We sent round circulars to say that our schools were not to alter their curriculum at all, that they were to keep up precisely the same system as before. Of course we did not get universal obedience, but still the effect of that sort of precept upon our part, and the reasonings with which it was combined, was to keep up very much the practice of the schools, especially where we had the best teachers, who did not wish to degrade themselves or their schools by giving up those scientific lessons.

8081. But the teachers themselves had no direct pecuniary advantage by continuing to teach science?—No.

8082. (*Sir J. P. Kay-Shuttleworth.*) Probably they had liberal Committees, and had a large staff of assistants?—They had liberal Committees. Our teachers are generally very well paid. Whenever it came to a hard fight for life, of course, everything would follow the grinding system, but where we had large schools and liberal Committees and large salaries there was not the same necessity, and especially where the children were drawn, as often happens, from the superior class of mechanics.

8083. (*Chairman.*) Do you think that one of the advantageous results produced by the Revised Code, would be that the average of the younger children, and the duller children more especially, were more satisfactorily taught under the provisions of that Code than previously?—I should like just to distinguish before I give an answer upon that point. If the Revised Code is considered to be identified merely with the principle of individual examination in schools, I do not doubt that, from the principle of individual examinations in schools, very good results have followed; but that principle was recommended before the Revised Code was in existence. It was recommended, I believe, by Sir James Kay-Shuttleworth, that a certain proportion of the grant should be made dependent upon individual examination, and I think that all who studied the question at that time were of opinion that a certain proportion, sufficient to make it worth while closely to look after the children, should be dependent upon individual examination, and, therefore, I do not consider that the principle of payment after ascertainment of results was really the principle of the Revised Code. I think that the principle of the Revised Code was to restrict education as far as possible within the limits of those particular subjects on which payment was made; that that was the governing principle of the Revised Code, especially as originally propounded in Parliament, and to dis-

Rev. J. H.  
Rigg, D.D.

5 May 1871.



Rev. J. H.  
Rog. D.D.

5 May 1871.

courage everything in the nature of higher education, and broader education, and deeper education; that it looked, in fact, to mechanical instruction in what are considered the three principal rudimentary branches. I have no doubt at all that many children were more or less neglected, and that in order to cure that individual examination was necessary, but I believe that individual examination might have been had without the general spirit and scope of the Revised Code.

8084. (*Sir J. P. Kay-Shuttleworth.*) Are you aware that there was a Minute in 1853 which provided for individual examinations, but which the Department did not carry out?—I remember that very well, and if it had been carried out there would have been individual examination nine years before the Revised Code. Now that the days of the Revised Code are over, my own feeling is that the Revised Code was intended to compress the school age within very narrow limits, to discourage children attending school after 10 or 11 years of age, and to restrict the education of the children within hard and narrow lines.

8085. What is your opinion, then, of the importance of a general development of the intelligence of children in schools, even with a view to their acquiring the necessary rudimentary knowledge of reading, writing, and arithmetic?—I believe that no children can be taught to read properly who are not taught a great deal besides reading. I believe that object lessons, and the eliciting of knowledge, and the capacity for the formation of ideas, are necessary in order to a child's being able to read easily or with sensibility and intelligence, and, therefore, that any attempt to get at reading simply by teaching reading is an entire mistake; a great deal more must be taught if the reading is to be thoroughly well taught.

8086. If you wanted to have the greatest success, in an elementary school, in teaching reading, writing, and arithmetic, you would not depend upon a system of mere cram in those subjects?—Certainly not.

8087. But you would have a more generally extended cultivation of the intelligence of children and their knowledge, in order to acquire the greatest success in those subjects?—Yes. As to arithmetic, I believe the system of merely getting at certain results in addition, subtraction, multiplication, and division, without showing what those processes mean, is a short cut, indeed, to what may be necessary for the lowest branches of commerce, but it neglects really the higher objects of education, and, in the long run, more or less fails.

8088. You think the mistake of the Revised Code was, the neglect, and even the discouragement, of the general cultivation of intelligence and of higher instruction, which had an injurious reaction upon instruction in the rudiments?—Yes.

8089. Have you observed the statistics of the amount of failure in reading, writing, and arithmetic which have resulted from examination since the Revised Code has come into operation, and are you aware that the amount of success in reading, writing, and arithmetic has by no means justified the course taken in the Revised Code?—I am aware of that, and at the time that the matter was under discussion I ventured to prognosticate that the results anticipated would not be attained by the methods which were resorted to in order to attain them, and more especially in respect of reading.

8090. (*Mr. Samuelson.*) With regard to the third year's students, of whom you have spoken, would you intend that some of them should occupy themselves entirely in the study of science, if there were any appropriate science college within reach, or would you continue their general education, that is, continue to prepare them as teachers in general subjects at the same time?—I think it would be a pity to give up the advantage that they had attained. I think that just sufficient should be done to prevent their losing the advantage of the two years' instruction in other things, whilst at the same time their chief attention

should be given to scientific studies, because, after all, in those schools of science we do not know what other branches might be more or less kept up by them. I cannot help thinking that it would be a great mistake, for instance, if you took a boy of 13 from a rudimentary school and sent him for three years into what is called a science school, that you should not have some other branches besides science in those three years in order to keep up his true and equable development. I think there ought to be, more or less, some instruction in English composition, or some recognition of history, however much you may make science the chief object in those superior schools; otherwise, to keep for three years any boy perpetually at science, I fancy, would be rather a mistake.

8091. You speak of youths of 13; but I was speaking of students in training colleges?—My point was this, I think if the teachers are to go from a three years' training to take charge of boys of from 13 to 16, and train them three years, it would hardly be wise if the boys in those schools learnt nothing in the world but science, and then I think it would be a mistake for any teachers who had developed their scientific aptitude to be so entirely given up to science for three years as not to keep up the amount of knowledge which they had acquired during the previous two years, because it might be exceedingly useful to them, and in those very schools of science for boys between 13 and 16. I think that a pure school of science would be as bad as a mere school of literature. Whilst it should be chiefly a school of science, there should be something more or less along with it, if you are to keep up a proper development of the intellect of the young people at all.

8092. But how would it be if their intention were to become teachers in science classes, which would be attended chiefly by adults?—That is quite a different case. There would be those science classes besides those science schools; but the idea is that of graduation, that scientific aptitudes should be elicited in the elementary schools, and should be trained and developed in the schools from 13 to 16, and, of course, over and above that, that the grown up young people from 18 to 21 might have scientific instruction. I imagine that the teachers for the highest class schools would be picked men out of the teachers for the lower class schools, and supposing that that were the case they would not have lost their previous training during the time they were in those schools from 13 to 16, and in giving other instruction besides science they would have kept up what they had previously acquired. After once they had grounded the whole and made it all good by practice themselves, and gained the status of good teachers in the broadest sense, whilst especially good science teachers, I think there would be no harm for such teachers to devote themselves entirely to teaching science to young men from 18 to 21 or 25. The only thing is, that I think that the idea of a large class of teachers, who teach nothing but science in elementary schools of boys from 13 to 16, would be a mistake, throwing away power and throwing away training. But after you had let them get their discipline and preliminary training in those schools, where their character was matured and settled, you might get the best teachers for young men of from 18 to 25 in connexion with the School of Mines and other institutions of that sort.

8093. Do I understand that even in respect of those young men, although they were only in their third year in a college like yours, you would wish them to continue their general education?—I do not mean that the third year's students in College, if the question refers to these, should continue their general education *pari passu*, but that they should be prevented from losing what they had already gained.

8094. With regard to the class of teachers of whom you spoke last, namely, those who are to have the direction of elementary schools of science for adults, do you think, taking into account the demand for



teachers at this moment, that the number of young men who could afford to remain and devote themselves more especially to the acquisition of a knowledge of science, merely retaining what they had acquired in general subjects as you have recommended, would be very large?—What I have said as to that is this, that, provided the inducements were adequate, there would be a sufficient number who would so continue; but that it would be necessary to have adequate inducements, that they must know that by staying the third year and succeeding fairly they would get a better status and better pay and a higher sphere of instruction; then, I think, with such inducements, there would be an adequate number who would remain for the third year.

8095. They would, you think, be prepared to sacrifice the opportunities of obtaining immediate employment at what, for their position in life, is a fair salary, in order ultimately to acquire a higher position?—I think they would be prepared to postpone for one year their entrance upon teaching in the expectation of being altogether elevated in their position, and having a more congenial field of work in the future.

8096. In that way you consider that those higher schools of science which you assume would be established throughout the country, or which you would wish to see established throughout the country, would be of very great importance, and of very great service to colleges like yours?—I think that our College is a matter of no importance at all in the question. It is not a question of what would profit our College, but what would profit the nation. I think it would involve the colleges in a good deal of trouble, that they would have a great deal of pains to adjust themselves to circumstances, and that those who wanted an easy life would not at all welcome any proposal of the kind, and I do not think that such schools would be esta-

The witness withdrew.

The Rev. WILLIAM J. UNWIN, M.A., LL.D., examined.

8100. (*Chairman.*) You are the Principal of the Training College at Homerton?—I am.

8101. I believe a science class has been constituted at that College in connexion with the Science and Art Department?—We have had a class for the last two years in connexion with the Science and Art Department.

8102. Have you other facilities for teaching science at the College?—No; that is the limit of instruction in that direction.

8103. What are the scientific subjects in which instruction is given to your male students?—This year we have taken physical geography; mathematics; theoretical mechanics; acoustics, light and heat.

8104. How much time do you devote to those subjects?—One hour on four days of the week.

8105. Are all those subjects undertaken by the same teacher?—They are all undertaken by the same teacher.

8106. What has led to those subjects being selected?—Chiefly because they are related to the other subjects of instruction, and bear more directly upon the future work of the students. The principal point kept in view has been not to interfere with the examination based upon the syllabus of the Education Department.

8107. The Homerton College is under the Congregational Board of Education, is it not?—Yes.

8108. Are they of opinion that science is taught to a sufficient extent in the College?—We think that it is taught to as large an extent as is possible consistently with our obligations to the Education Department.

8109. Your system of education is prescribed to a great degree, or mainly prescribed, by the syllabus?—Yes.

8110. And the syllabus does not admit of more time being devoted to the special teaching of science?

lished everywhere. I think that they ought to be near enough to become centres to groups of elementary schools of very considerable number. I think it would take a great many elementary schools to furnish a school with boys having an aptitude for science at the age I refer to, but I think it would be a great benefit to the nation, in its economical and intellectual development, if an opportunity were given for the establishment of such schools everywhere centrally.

8097. And that they might be made to work harmoniously with colleges like yours?—I think so. I am not prepared to give a definite opinion upon the subject, but it appears to me that it might be possible to devise a plan according to which students in colleges of that description might have a third year, and gain the requisite amount of training, and then go into those schools, and then the élite of them be permitted to be teachers of young men in schools of mines and places of that sort.

8098. (*Sir J. P. Kay-Shuttleworth.*) You are aware that the school organisation of the country has been generally denominational, have you any doubt whatever that in your College, with a view to those scientific schools, you could prepare young men of high character and good conduct who would go forth and give such instruction as might be required by the State and by the community without having any denominational tendency in their working of that system?—I cannot imagine that when it comes to science schools denominational bias or tendency would have any place at all. We do not find that our teachers are pre-eminent for denominational bias, but, I think, the contrary.

8099. (*Chairman.*) Are there any points that you have omitted upon which you could give the Commission any information?—I am not aware of anything further.

—We could not give more time unless there were some modification of the syllabus. The substitution of the continental methods of teaching geometry for the elements of Euclid would probably save time and labour, and be more useful in the direction of scientific teaching.

8111. Has that point been much considered by the authorities of the College?—No; I give this as my own opinion simply, as having the direction of the course of instruction.

8112. Is the subject of "economy," as prescribed in the syllabus, sufficiently defined, in your opinion?—No; the teacher of that subject can hardly know in what direction his teaching should go, and it, therefore, takes a large amount of time. It has occurred to me that a stricter definition of that subject would possibly give time for the teaching of some specific branch of science, and I think in this opinion both Inspectors and the authorities of Training Colleges would agree.

8113. Is much of your time occupied in endeavouring to meet the requirements under this head of "economy"?—Yes; it occupies two hours a week, and the results are uncertain. Anyone who looks at the examination questions, and compares them with the syllabus, will find that the teaching required must have a wide range.

8114. The character of the examinations varies greatly, does it not, from year to year?—The examination varies considerably from year to year.

8115. Have you ever made representations as to the defects which you consider to exist in the syllabus under this head?—No, we have not been connected with the Education Department very long, so that we are hardly in a position to raise this question.

8116. If that subject were more strictly defined, you have stated that more time would be at your command, to a certain extent, for other branches of science; have

Rev. J. H. Rugg, D.D.

5 May 1871.

Rev. W. J. Unwin, M.A., LL.D.



Rev. W. J.  
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LL.D.

5 May 1871.

you any other suggestions to make as to any plans by which the teaching of science might be carried on to a greater degree?—Not without a change in the general arrangements of training colleges, such as the extension of the course of instruction from two to three years, or giving to the students who show particular aptitude in the direction of science, exhibitions by which they might prosecute their studies more formally than they can do in a training institution; and if there were a duly qualified class of teachers specially charged with the teaching of science in training colleges, the instruction would be much more efficient. It would be also a great improvement if the science subjects were included in the syllabus, and marks given for them as for other subjects in awarding certificates.

8117. What are your views as to extending the period of training from two to three years?—It involves very considerable difficulty with regard to the students, who, during that period, are not earning any money, and who, therefore, would be less likely to enter training institutions if that impediment existed.

8118. Do you think that if students had an opportunity of remaining a third year many would avail themselves of that opportunity?—I hardly think they would unless it were made compulsory, or some solid advantages were presented to them to induce them to take a three years' course.

8119. Do you consider two years a sufficient period for training teachers who are to take charge of elementary schools?—I should hardly say that it was sufficient, but it is probably as much as can be secured at present. It used to be 12 months; further back, six months, and further back still, it was brought within the range of four or six weeks; but, as it has been extended to two years, the addition of another year is not improbable. On the continent, the training of teachers is usually for three years.

8120. Is two years at present a compulsory period?—It is compulsory for all who take any but infant schools. A slight modification for this and next year has been made, but this will not be a permanent arrangement.

8121. If a pupil at the end of his first year or at the end of a year and a half is offered employment, can you prevent his accepting it, if the managers of the school are willing to take him?—Every student signs a declaration which is forwarded to the Education Department, stating that he will continue his period of training for two years, and will not abandon it for any other work.

8122. Are the terms of that declaration generally adhered to?—I have not sufficient experience as to that, but I believe there is no considerable lessening of the number of teachers by their giving up their work within a reasonable time—the payment to the training college depends upon that; as unless they complete their course and obtain as teachers two satisfactory reports from their Inspectors, the College is not reimbursed the cost of their training by the Education Department.

8123. But you would consider three years desirable, as the period of training for teachers who are merely to undertake ordinary elementary schools?—Yes. Their success, especially in teaching scientific subjects, would be greatly promoted by a three years' course. Many, when they enter training institutions, are hindered by deficiencies, which take up much time in correcting, such as faulty spelling or bad handwriting, and, generally speaking, great inability to express themselves correctly in English composition.

8124. Are you of opinion that if exhibitions were attainable by your best students, on condition of their prosecuting their studies for another year, at any special college that might be founded, many would be competitors for such exhibitions?—That plan has suc-

ceeded in other directions so well, that it would in all probability work advantageously.

8125. What are the instances of that system to which you refer?—In the Art Department at Kensington, special scholarships are given.

8126. Should you look with favour on the employment of teachers of science not belonging to the College staff, but coming to the College specially for that purpose, to give instruction in science?—The instruction would be more efficient if science were taught by those who devoted their whole time and thought to that subject. A person who has to teach several subjects cannot be expected to teach science so well as one who has nothing to think of or to do but that, and the students also would be inspired with more confidence in the teaching of anyone so qualified.

8127. Does your present science teacher also teach other subjects?—Yes, he teaches mathematics and geography, and economy.

8128. Would the plan of having scientific subjects taught by teachers not belonging to the staff of the College involve any considerable additional expense? We adopt the present plan on the ground of economy simply; but we have teachers who undertake only one subject; music is taught by a non-resident teacher; drawing is taught in the same way; in both cases the teacher devotes all his time to the subjects he teaches in the College. A similar method for teaching science would obviously be most advantageous.

8129. Your pupils, as a rule, become teachers of elementary schools, do they not?—Yes.

8130. Have any considerable proportion of them also become teachers under the Science and Art Department?—We have only been in connexion with the Science and Art Department for two years, but most of the students will take certificates which will qualify them for giving instruction in elementary schools, and to evening classes.

8131. Do you think that the object of training science teachers can be in the most satisfactory manner accomplished by a College such as yours?—I do not. The importance of science teaching will be increasingly felt, and thus will necessitate some special arrangement. A Science College is necessary to give adequate instruction, and to provide teachers to meet the demand likely to arise.

8132. Would you contemplate, if such an institution were established, that your College would enter into connexion with it, and that any proportion of those more advanced students would resort to such a College?—We should gladly enter into connexion with a Science College, and encourage any students who give promise of success to avail themselves of its advantages.

8133. (*Mr. Samuelson.*) I think you spoke of the employment of duly certificated teachers of science in the College as one of the means which you would adopt in order to extend the teaching of science?—Yes; the teaching at present is under the superintendence of one of the College staff, who, in addition to teaching science, has to teach other subjects. It would be an advantage if we had a science teacher who would take such subjects as may be deemed desirable.

8134. Whence would you propose to procure such teachers?—From some institution like that at South Kensington. The Art Department at one time prepared and sent out teachers to give instruction in drawing in schools. They do not do so at present, because, I suppose, they have found that teachers can be easily procured otherwise. I should say that it would be desirable if we could have teachers, duly certificated and qualified, who would undertake science as those teachers undertook drawing in years past.

8135. They still have an Art Training School, and I suppose you would contemplate the establishment of a Science Training School?—Yes.



8136. You would look rather to persons trained in such an institution than to those simply holding a certificate under the Science and Art Department?—The instruction would be carried to a higher point than is required for a certificate, and would be connected with a wider culture.

8137. Have you any knowledge of the qualifications of the persons who hold a teacher's certificate in science at this moment?—I have no knowledge beyond the examination papers, and what I know of those who have obtained certificates. I have no other means of knowledge.

8138. You have not inquired specially into that?—No, I have not had any occasion to do so.

8139. But you have given no special consideration to the subject?—Not beyond the opinion I have formed that men who can only pass the papers required for a certificate, cannot be so well qualified as those who have had a thorough training in science.

8140. (*Professor Smith.*) You are of opinion, if I understand you rightly, that it is a mistake for the syllabus of the Committee of Council on Education to prescribe strictly Euclid as the general geometrical text book?—I think it would be found more advantageous to adopt the French method, which generally obtains upon the continent. The syllabus prescribes the first four books of Euclid; and it has occurred to me that it would be more suitable for them to adopt some other method of demonstration than that which is furnished by Euclid's Elements.

8141. That would be particularly necessary if teaching in other branches of science were introduced, would it not, with the view of economising time?—Yes, it would economise time and labour.

8142. The properties of similar figures are not in the least included in the syllabus, are they; it just stops short of that?—Yes, students have to get up the four books, and to do certain deductions from the propositions.

8143. With a view to its subsequent application in physical science, it would be very desirable, would it not, that the time spent in certain parts of the third book of Euclid, or the fourth, might be devoted instead to acquiring some knowledge of the doctrine of proportion as applied to geometry?—Yes.

8144. (*Chairman.*) Are there any other points upon which you could supply us with any information upon which we have not asked your opinion?—The only other subject to which I would advert is the introduction of science teaching into elementary schools. I have long had a decided opinion that a modification in our infant school system is most desirable. The arts of reading, writing, and the elements of arithmetic might be taught to children at a very early age, and much of the excitement found in infant schools might with advantage be got rid of. There should be abundance of physical exercises and suitable oral lessons; the lessons should be short, and the children's minds should not be to any large extent overtaxed; but, from experiments I have made, I believe that two years might ordinarily be saved in the education of children; that is to say, at seven they might, I think, be able to read fairly an easy narrative, might understand computation in the simple rules, and might be able to write very fairly. If writing were commenced with the teaching of reading, or, rather, if reading were taught by writing, as is common on the continent, much would be gained, and when a scholar passes at seven into the juvenile school, he would have nothing to unlearn, and would find his subsequent progress largely promoted.

8145. At what age do you think such instruction in science might commence?—No formal instruction, I think, could commence until after the child had passed through the infant school and the juvenile school,

which I presume he might leave at the age of 13. It is impossible to do it before, because the mental faculties necessary for the acquisition of science are not developed. The great difficulty we have to contend with, in reference to primary education, is, that children of such different ages are taught in the same school. The Swiss system of graded schools is most advantageous, about 50 children are under one teacher for a year, then they pass into the hands of another teacher for a year, until the course of education is finished. But to secure satisfactory teaching in science, secondary schools, for children who have completed their course satisfactorily in juvenile schools, are essential.

8146. Do you think that reading, writing, and arithmetic does not begin early enough?—Time is lost, from, say, four years of age to seven. In infant schools, as far as I am acquainted with them, there is a large amount of excitement; and I believe that a practical system of instruction such as I have indicated might save at least from one to two years.

8147. To what age do you consider that children usually remain at infant schools?—Generally till six or seven.

8148. Are most of those that leave unable to write?—They are generally able to write, but in writing, reading, and the elements of arithmetic might show higher results. As the problem is to get a fair education and yet not interfere with the demand for juvenile labour, we must make some provision which will meet the case of children in the humbler ranks of society; and, as their education is not likely to be carried on to any very large extent, I do not think that they are likely to suffer from an over stimulus of the brain at an early period of life by the adoption of the course I have indicated.

8149. (*Sir J. P. Kay-Shuttleworth.*) Are you acquainted with the methods of instruction that were introduced by Dr. Scherr, in the schools of the Canton of Zurich, of beginning instruction in reading by teaching writing?—Yes, I am. I have adopted his methods to some extent.

8150. You have found it difficult to find persons of sufficient skill, and have been scarcely able to give your own mind sufficiently to it, to attain a fair success in it?—The results secured were most satisfactory.

8151. Have you visited any schools in Zurich in which Dr. Scherr's system has been carried out with the greatest success?—I have.

8152. And you have been struck very much with the results of that system?—Yes, and not only so, I said to a teacher, whom I obtained from Switzerland, "Take the youngest class and do what you can for three months. I will then test the results." These I found very satisfactory. In Swiss schools the process is slow, but it always involves progress. In this country there is a want of systematic progress. Instruction too much resembles a door on its hinges, constant motion but no progression; in Switzerland, as far as I know the schools there, however little a child does, he proceeds from it a little further and then a little further. We want that in England.

8153. You probably have been as much astonished as many other persons have at the wonderful proficiency of children taught in these schools upon Dr. Scherr's method, in writing at a very early age?—Yes.

8154. And by the method of acquiring, at a much earlier age than in this country, the power of reading also printed characters?—Yes.

8155. Have you also attempted any modification of the Pestalozzian method of teaching arithmetic in your school?—I have adopted Dr. Scherr's method, which is virtually founded upon that of Pestalozzi.

8156. That would probably convey the impression to your mind that there is at present a want of

Rev. W. J.  
Unwin, M.A.,  
LL.D.

5 May 1871.



Rev. W. J.  
Unwin, M.A.,  
LL.D.

5 May 1871.

analytic precision in the methods which are adopted in English schools?—I think there is.

8157. If there were a more delicate analysis of the subjects taught, the success would be, as in Switzerland, more certainly progressive and effective?—Yes.

8158. Are you acquainted with the methods of

teaching reading in the Dutch schools?—No, I am not.

8159. (*Chairman.*) Is there any other point upon which you would like to favour us with your opinion?—I am not aware that there is anything that I can add to what I have stated.

The witness withdrew.

ALFRED BOURNE, Esq., B.A., examined.

A. Bourne,  
Esq., B.A.

8160. (*Chairman.*) I believe you are the Secretary of the British and Foreign School Society?—I am.

8161. Will you be so good as to state to the Commission to what extent the teaching of science is provided for in the system of instruction imparted at the schools of the British and Foreign Society?—The Society has for many years given prominence in the instruction imparted at its schools to the knowledge of common things, upon which science is based. The Lesson Books adopted by the Society have lessons on such subjects as these, the use of flowers, ventilation, physical geography, the mechanical powers, the atmosphere, the equilibrium of fluids, the velocity of sound, the solar system, the crust of the globe, earths and fossils, and various lessons of the same kind.

8162. Do you require those to be universally taught in all your schools?—No; we provide the book which is in common use in the school, but we have no examination in those subjects.

8163. (*Professor Huxley.*) What are the titles of the books?—The Daily Lesson Books: there are six of them, No. 1 to 4, with a "Sequel to No. 2," and a "Supplement to No. 3."

8164. Are they known as your books?—Yes, the Daily Lesson Books of the British and Foreign School Society. I should say that the introduction of the Revised Code has led to the issue of a set of Revised Lesson Books in which a good many of those lessons are left out.

8165. (*Sir J. P. Kay-Shuttleworth.*) What I understand you to say is, that on the chapters in the Lesson Books, the heads of which you have given to us, it was the custom of the schools to give a certain amount of explanatory instruction for the development of the general intelligence and knowledge of the children, and to make that the subject likewise of questioning in the class; but that since the Revised Code was passed, that has been omitted to a great extent?—I should say that those books are still in use in a great number of the schools, but there is an abbreviated form which is used in a great many of the schools under Government inspection.

8166. And that in those schools which would be inferior in staff and in the liberality of the Committees to the teachers, and where it was, therefore, more necessary to earn the grant by the production of the results which are requisite for that purpose, the amount of instruction given under those heads would be by so much diminished?—Certainly.

8167. (*Chairman.*) Is the abbreviated book issued under your authority?—Yes.

8168. In many of the best or most flourishing schools, is the full system still in operation as it was previously to the Revised Code?—I think in all our schools a certain amount of instruction of the same kind is given; although those books may not be used, it is open for the teacher to give collective object lessons which would convey a good deal of the same instruction, even where it does not occur in the reading book.

8169. To what extent is domestic economy taught in the British and Foreign School Society's schools?—The teachers whom we send out from the Female Training College at Stockwell are taught, throughout the whole period of their training, such subjects as the best methods of cooking various meats, the constituents

of food, the best method of treating slight ailments, the way to manage domestic service and cleaning, and the various duties of servants; and those teachers, when they go into schools, give lessons upon those several points.

8170. (*Mr. Samuelson.*) How are they taught cooking?—In the Female Training College they take their turn in the kitchen; two of them go down at a time in order to assist in the cooking operations, so as to obtain a practical knowledge, and they have lessons which embrace the theory.

8171. (*Chairman.*) We understand that you have two training schools in London, the Borough Road and the Stockwell School?—Yes, for male students at the Borough Road, and for female students at Stockwell.

8172. What scientific subjects are included in the curriculum of your Training Colleges?—At present the following: mathematics—a class in each of the four stages, one, two, three, and four; theoretical mechanics, chemistry, elementary and advanced, and physical geography, that is at the Borough Road College for young men. At Stockwell there are two classes, one in connexion with the Science and Art Department, and one independent of that Department. The one in connexion is in physical geography, and the one which is not connected with the Department is in animal physiology.

8173. (*Professor Smith.*) Are the stages that you refer to those of the South Kensington examinations?—Yes, they are. The stages are prescribed by the Science and Art Department, and the examinations are held in connexion with that Department.

8174. (*Chairman.*) What is involved in the term "connected with the Science and Art Department?"—The Science and Art Department requires that a Science Committee should be formed; that Committee has theoretically and, to a large extent, practically the appointment of the teachers, the management of the class, and the receiving of the fees, if there are any fees. At the Training Colleges we have no special fees. The Committee so appointed meets on the prescribed evenings, receives the papers from the Science and Art Department, distributes the examination papers to the students, watches the writing of the answers, seals up the answers, and sends them back to the Department for examination.

8175. Did you make any alterations in the curriculum of your Training Colleges in consequence of the provisions of the Revised Code?—I really can hardly say, for I was not connected with the Society at the time. My experience is all under the *régime* of the Revised Code.

8176. Can you furnish the Commission with a statement of the results of your classes in connexion with the Science and Art Department?—Yes. I have tabulated the results for the last three years, during which there have been examinations connected with the Department, 1868, 1869, and 1870, stating the number who have received instruction, the number who have been presented for examination, the number who have passed the examination, the number of prizes received by the students, and the number of certificates received by the students; and I will beg leave to hand in the following table:—



SUMMARY of RESULTS attained at the Examinations of the Science and Art Department.

A. Bourne,  
Esq., B.A.  
5 May 1871.

		1868.	1869.	1870.
Number who have received instruction in		69	92	98
" " been presented for examination in		67	92	87
" of passes	Pure Mathematics (Borough Road).	63	60	58
" prizes		28	6	17
" certificates		6	15	34
" who have received instruction in		—	40	46
" " been presented for examination in		—	40	40
" of passes	Theoretical mechanics (Borough Road).	—	23	30
" prizes		—	1	11
" certificates		—	4	1
" who have received instruction in		—	86	82
" " been presented for examination in		—	86	80
" of passes	Inorganic chemistry (Borough Road).	—	83	65
" prizes		—	9	29
" certificates		—	9	13
" who have received instruction in		—	99	98
" " been presented for examination in		—	99	96
" of passes	Physical geography (Borough Road).	—	69	75
" prizes		—	13	7
" certificates		—	23	37
" who have received instruction in		—	49	46
" " been presented for examination in		—	33	41
" of passes	Physical geography (Stockwell).	—	32	41
" prizes		—	—	16
" certificates		—	—	—

8177. You have five classes, apparently, in connexion with the Science and Art Department?—We take five of the subjects on the South Kensington list, Nos. IV., V., VI., X., and XXIII., viz., pure mathematics, ditto, theoretical mechanics, inorganic chemistry, and physical geography. In Nos. IV. and V. we have three classes; in No. X. two classes; in No. XXIII. two at the Borough Road Training College, in addition to the class in the model school, and the class at Stockwell.

8178. Is the attendance at those classes optional with the students of the Borough Road School?—

It is as a matter of fact, with very few exceptions, they wish to attend, but there is no compulsion. In several cases the teachers have advised them not to do it, under the impression that, from the character of their minds and the necessity of pursuing their studies in other directions, it was better that they should not give their time to it.

8179. What arrangements have you made as respects the time given to those science classes?—The time table, which I will put in in evidence, represents the time at which each of the classes are held, and it is as follows:—

Subject.	Class.	Stage.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
Pure mathematics	1	I. and II.	6-7½ P.M.	—	11-12	—	—	10-11
	2	II. and III.	9-10 A.M.	—	4-5 P.M.	—	—	11-11½
	3	IV.	—	9-10 A.M.	—	—	11-12	—
Mechanics and natural philosophy	—	—	7½-8½ P.M.	—	—	—	—	9-10
Chemistry	Senior	—	4-5	—	—	4-5	—	10-11
	Junior	—	—	2-3	—	—	9-10	11-11½
Physical geography	Senior	—	11-12	—	11-12	7½-8½ P.M.	—	—
	Junior	—	—	4-5	—	6-7½ P.M.	4-5	—

N.B.—A certain amount of elementary mathematics enters into the regular curriculum. This nearly corresponds to the first stage of the Science and Art Department; consequently, no grants are made by that Department to training colleges for instruction in this stage, and all students who obtain the ordinary schoolmaster's certificate are recognised as qualified to teach it. The hours given in the time table are in addition to those assigned in the regular curriculum for this elementary work.

The abilities of the students for mathematics vary so much that for some the elementary work required by the Education Department is quite sufficient, but a good many are able to take the second stage, and a few advance to the higher work of the third and fourth stages.

The principle of the arrangement is this, that we interfere as little as possible with the regular work of the College. The regular work has reference to the examination of the Education Department; it is with the Education Department that our primary relations exist, and that work is not allowed to be set aside for anything extraneous, such as these science classes.

8180. Still, without neglecting your regular work, you are able to set apart a considerable number of hours in the week for science instruction?—Yes; I should explain, in connexion with this table, that the same students are not attending the science classes at all those times.

8181. I presume that very few would go in for more than one or two of those classes?—A good many of them take three of the subjects,—few more than that.

8182. Those classes are held from February to May; why are they limited to those months only?—Because the examination comes on in May, and in order to secure the attendance of the same students throughout, it is necessary to begin in February, when the session commences. We introduce a large number of new students in February, and the only space which can be devoted to the regular science instruction is between the coming in of the students in February and the time of the examination in May. In mathematics



A. Bourne,  
Esq., B.A.

5 May 1871.

and mechanics they pursue the study through the year, that being part of the ordinary curriculum of the College.

8183. Your students, as a rule, remain two years, do they not?—Yes.

8184. And can the same students go in in the two successive years to those classes?—They take the elementary stage in the first year, and they may take the advanced stage in the second year; or with mathematics, if they take the first or second, in the first year, they may take the second, third, or fourth in the second year.

8185. It appears by the table that both in pure mathematics and inorganic chemistry, six or eight hours a week are given to each of those subjects?—Yes; it would be two or three hours for the advanced stage, and three hours for the elementary stage.

8186. The same students do not give up more than three hours during the week?—I have not the exact figures to refer to. Where the students take several subjects, the number of hours is greater.

8187. Do you think it would be practicable to increase the number of science classes?—I think it is quite possible that we might change the subjects, but I do not think we could give more time, and yet prepare the students for the ordinary work of an elementary school.

8188. What is the number of subjects connected with the Science and Art Department?—23.

8189. Can you furnish the Commission with any suggestions that may have presented themselves to your mind for turning the science teaching in the training college to greater account?—The only suggestion that I would make is, that if something of the same kind could be done for science as is done for drawing, so as to lead to the general introduction of elementary science teaching into our schools, and an annual examination of the scholars be held, apart from any extra science classes in the evening, or out of the regular school hours, it would give a pecuniary value to the certificate which the students gain when in the college, and it would keep up to a very large extent their scientific studies; it would tend to increase their own knowledge, and it would develop in a great many cases in the children a love for that sort of study which would lead them to attend science classes elsewhere after they left that school.

8190. Have you a statement to make in support of this suggestion which was presented to the authorities by the teacher at Stockwell?—The teacher of school management at Stockwell has within the last 12 months introduced, not so much for the sake of extending scientific knowledge as of increasing the interest of the lessons which the teachers have to give to the children, conversational lessons on zoology and botany; and her testimony is to the effect that even their pursuing the subject in a very rough and ready manner has so interested the students, that they are very anxious to do something of the same kind in their own schools.

8191. Have you been a good many years connected with the British and Foreign School Society?—Three years.

8192. Do you know whether many of the teachers that you have sent out are teaching now in connexion with the Department of Science and Art, in addition to their ordinary school duties?—It is quite possible that many may have obtained certificates apart from the College; but the science classes were only established in the training college in 1868, so that it was only the students who left in that year, and who have been out two years, who have been considered by the Department qualified to teach science classes; but a good many of those who left in 1869 and 1870 are teaching larger or smaller classes in the neighbourhood of their schools.

8193. Do you imagine that the greater part of those students comprised in this table have gone through the examination with the view of becoming teachers of science themselves?—I should say that they have, that they wished to qualify themselves for teaching

science classes, provided the opportunity presented itself in the neighbourhood in which they may be settled.

8194. (*Marquis of Lansdowne.*) By whom is the scientific portion of the Lesson Books in use by the Society compiled? is it by members of the Society itself?—The books originally were prepared by the Secretary of the Society for the time being, and the teacher of the model school. Where the facts or the extracts were taken from, I am not prepared to say.

8195. That would have depended upon the Secretary for the time being?—Yes. The books were not prepared by the Secretary officially, but Mr. Dunn and Mr. Crossley (the master of the practising school at that time), feeling that books of the kind were required, combined to prepare them.

8196. In those lessons which are enumerated in your précis, is there any attempt at a classification of the different elementary sciences, or are they simply little isolated facts which you thus bring to the notice of the children?—There is a classification which runs through the book, certain subjects, such as physics, natural history, general history, and English history, being taken up. The lessons on the several subjects do not follow in immediate procession, they are interspersed, but the table of contents shows them in a collective form, so that the teachers might take them one after the other if they desired.

8197. (*Mr. Samuelson.*) You have put in a table of the results obtained at the examinations of the Science and Art Department; in speaking of certificates, do you mean teacher's certificates as having been obtained?—The certificates which are given by the Science and Art Department and qualify the teacher to hold science classes.

8198. Is that the certificate authorising them to conduct classes, and to receive payments on results?—Yes.

8199. Who are the persons who conduct the science classes in your training school?—In each case, the teacher of ordinary subjects in the College; the Principal at the Borough Road teaches chemistry, the mathematical tutor mathematics and mechanics, and the resident tutor teaches the physical geography.

8200. What is the evidence of their qualification as teachers?—That which is recognized by the Science and Art Department as qualifying them, namely, the possession of the London University Degree of Bachelor of Arts; that degree is recognised by the Science and Art Department as entitling a teacher to hold science classes.

8201. Ranking with their own certificate, or as a substitute for their certificate?—As a substitute for their certificate, that is to say, a sort of honorary certificate is given to those who hold that degree.

8202. (*Professor Smith.*) What led, three years ago, to the establishment of those classes in natural science in the Borough Road Training College?—The proposition, I suppose, on the part of the Science and Art Department, to give certain pecuniary results to the teachers of science classes led the teachers of the College to propose to the Committee the establishment of those classes.

8203. Then it was principally owing to the action of the Science and Art Department at South Kensington?—Yes; in the case of most of the science classes. The animal physiology was introduced at Stockwell at the wish of a lady who offered to give prizes to the students if they had instruction of that kind; but, as to the others, so far as the actually existing classes and their immediate predecessors are concerned, it was owing to the offer on the part of the Science and Art Department to give assistance to science classes. I think Sir James Kay-Shuttleworth will know better than I do that there was science teaching originally—there was a class of chemistry. I was asked, some time ago, as to what changes had been made in the curriculum, owing to the introduction of the Revised Code. I do not wish to answer the question, because I have no personal knowledge of it; but I would just say, incidentally, in



connexion with your question, that there were classes of that kind; there was a chemistry class I know before that time, because the present teacher of chemistry used to teach chemistry then.

8204. (*Sir J. P. Kay-Shuttleworth.*) Have you laboratories for instruction in practical chemistry in connexion with the Borough Road Schools, or in experimental physics?—None at which the students can experimentalize for themselves, but we have one for the teacher of chemistry, which he is able to use

in preparing experiments to be performed in the course of the lectures.

8205. But the students do not receive practical instruction in manipulation in those laboratories?—No, they do not. There have been several cases in which one student has wished to follow out a certain experiment, and he has been admitted as an exceptional thing, but it is not the regular thing.

8206. (*Chairman.*) Are there any other points upon which you would wish to give the Commission information?—I do not know that there are.

The witness withdrew.

Adjourned to Tuesday next, at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Tuesday, 9th May 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

Sir JOHN LUBBOCK, Bart., M.P., F.R.S.

Sir JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

The REV. CANON ROBINSON, M.A., examined.

8207. (*Chairman.*) I believe that you were the Principal of the York and Ripon Diocesan Training College for several years?—From the year 1853 to the year 1863.

8208. During that period what is commonly called the Revised Code came into operation?—It only began to come into operation just as I was leaving York. I was there under the old state of things. In fact I was there under two conditions of things. I found the College in a transitional state when I went there. It had been, in the first instance, a college where the majority of the students were not pupil teachers, but students who had been sent by country clergymen to be trained for a year or so, and to go back to country schools. The students of the College were in many cases very deficient, indeed, in attainments; they only got a superficial training, with a little general knowledge, and then they went back to keep small country schools. But the pupil teacher system was coming into operation at that time, and we gradually increased our number of pupil teachers, and diminished our number of candidates of another class, until, by the time I had been there two or three years, I think we scarcely had any students in the College who were not pupil teachers, and who had not served an apprenticeship of five years, who had not been regularly taught, nearly all being Queen's Scholars. Of course that class of teachers was very much in advance of the older type; they came up fairly well prepared; many of them were men of very considerable ability, and carried their course of study considerably higher. I found, when I went to York, a certain amount of science teaching in the College, but not a great deal. My predecessor was a man of some scientific attainments, and he had endeavoured to give lectures in chemistry, but the character of the students was such that they were not able to turn them to very much account generally. I must own, that under my own management, we rather took the line of literature than of science. I am not a man of scientific attainment, myself, and I rather developed the College in a literary direction. We introduced, at my suggestions English literature, and Bishop Temple, who was then the Inspector, persuaded the Education Department to admit that on to the syllabus, and we gave very great prominence to it.

8209. Was science taught to any extent during the period that you held the office?—It was scarcely taught at all. We took advantage of the Government Minute, which, I think, was passed in 1854, authorising

the appointment of lecturers, with a payment of 100*l.* a year to each lecturer. The first lecturer whom we appointed passed in physical geography, and that was thoroughly and extensively taught in the College. That was the one branch of science to which we did pay some attention. We sent in a lecturer also for applied mechanics, but he failed. Our third lecturer passed in English history, which is a purely literary subject. The course of study laid down by the Government gave the choice of alternative subjects, and we generally took either English literature, languages, or mathematics, and omitted the scientific department, as we were allowed to make our choice. The few students, also, who remained for three years, and who were allowed to take a high course of reading, during the third year selected either Latin or moral philosophy, and we passed men in both.

8210. What became of those third year's men?—They went to schools of rather a higher type. One of them, the best man that we ever sent out, as a third year's man, has been very successful, indeed, at the well-known school of West Buckland. I sent him there when the school was opened; he has left now, but he has been there most of the time since he left the College, and has made that school what it is.

8211. Have you had any opportunities of observing what the action of the Revised Code has been on the higher teaching?—I have had no direct opportunities of doing so myself, but I could judge to a certain extent from past experience what the probable effect would be, and my own impressions have been very much confirmed by the testimony of all those with whom I have conversed, with the masters whom I left behind me at York, and others. There was necessarily a depreciation in the whole system of study, and very many persons connected with the Training Colleges have altogether condemned the change. I think, in some respects, it is to be condemned, but I am not quite sure that I should speak as strongly as, perhaps, others may speak upon the subject. There was some justification for it. The students, the greater part of them at all events, did not come into the Colleges with very much acquirement, and they were apt, in attempting to take high subjects, to neglect elementary subjects, so that there was a danger of an unreal and superficial sort of training, a man endeavouring, for instance, to acquire some knowledge of Latin with a very imperfect knowledge of his own language; but the great fault of the syllabus, I think, is, that it consists too much of

*A. Bourne,*  
*Esq., B.A.*

5 May 1871.

*Rev. Canon*  
*Robinson, M.A.*

9 May 1871.



*Rev. Canon  
Robinson, M.A.*

9 May 1871.

subjects that are either elementary or that are not of a very educational character themselves. For instance, such subjects as geography and English history cover a very wide range, and the amount of time which a student must devote to them is not compensated for by the amount of training that he gets from them; he gets a great number of facts into his head, but he seldom gets the power of using those facts to much purpose.

8212. Does the syllabus date later than the Revised Code?—The syllabus followed the Revised Code, I think in the succeeding year. I only speak from memory. As your Grace knows, the last six or seven years of my life have been rather out of association with Training Colleges, or with that particular branch of work.

8213. Have you had any opportunity of examining the New Code which has just been issued?—Yes; I have looked through that code, and there seems to be a promise of better things there. Some encouragement is given now in elementary schools to what are called specific subjects; the payments on results are not simply for reading, writing, and arithmetic. I may, perhaps, be allowed to say that I do not quarrel with the principle of payment by results. I think, in that respect, the Revised Code has been, on the whole, an advantage. I believe it has brought about the effect of having elementary subjects more thoroughly and more generally taught in schools, and probably it will be found that there are more boys who have the faculty, at all events, of reading mechanically than was the case before. I think it is very desirable that, in addition to the payment on those elementary subjects, there should be encouragement given to higher subjects, and that the New Code of 1871 gives by the payment of 3s. to each scholar who passes in one of certain specific subjects, which the scholars are at liberty to choose from a very considerable number. The only objection to the code in its present form is, that the limitations are so great that a school can very seldom, I am afraid, gain all the advantage which it ought to gain from the arrangement. The limitation is to 15s. a head; and as the payment is 6s. on the average attendances, 12s. on the elementary subjects, and 3s. on each of two specific subjects, it follows that the maximum which a scholar might earn for his school is 24s. When he has done that, the earning is cut down to 15s., so that it destroys very much the encouragement of the study of higher subjects; they can get as much money without them as with them, in fact.

8214. Do you know what was the highest amount that a teacher could earn under the code which has just been superseded?—The limit was the same, I think, but the average amount was 4s. The payment upon each subject was 2s. 8d.; that was 8s., making a total of 12s.

8215. Now 12s. is raised to 15s.; was 12s. the maximum previously, and 15s. the maximum now?—No; 12s. represents the amount that any pupil could earn, as opposed to 24s., the amount he can earn under the present code. The limit on what is actually paid is what it was before, viz., 15s. on the average attendance.

8216. Then it is doubtful whether, under the New Code, there will be really any practical encouragement for the teaching of any other subjects than quite elementary ones?—I would not say that, because it would also increase the chances of the teacher in earning his money; it gives him a wider margin, and he may be induced, therefore, to make himself as safe as he can, not only by teaching elementary subjects, but by having other subjects to fall back upon.

8217. A man might think it an easier way of earning 15s. by attending exclusively to the more elementary subjects?—He would be tempted to introduce for his own sake the higher subjects, because the teaching of them is much more agreeable than mere routine elementary subjects.

8218. Do you think that that is generally the case with most teachers?—I think so, and one argument in favour of the Revised Code was, that the ten-

dency of teachers before was to devote their time and attention in a very great degree to the higher classes, and to subjects that could be taught in a more rhetorical sort of way. For example, in history he could take an incident, or an epoch, and lecture to his class, which was much pleasanter than a hard grind at elementary arithmetic or at mechanical reading; and it was, to a certain extent, true that the teachers from the training colleges were disposed to pay more attention to those subjects which had a little show and interest about them, and with which they could make a little display in the school, and to neglect the more mechanical work.

8219. Then you expect that the New Code will have a certain amount of influence in encouraging teachers to give more time to the higher subjects?—I hope so, and I think that the effect of introducing that provision will be to restore the higher subjects in our better elementary schools to the position that they ought to occupy. In many of the schools it would be very difficult to do much, because the children stay for so short a time, and hitherto they have been so very irregular in their attendance. In connexion with that subject, I may, perhaps, mention that we hope, on the Endowed Schools' Commission to give an additional encouragement in the case of primary schools that are also endowed schools, by applying some of the endowments to the same purpose, and by restricting the trustees in fact to use the endowments for the purpose of those higher subjects, so that they may be able to encourage boys to remain longer at school, and to take those subjects, by giving them prizes and exhibitions on condition that they do so. In schemes which we have put out for elementary schools, we have introduced clauses to that effect, that the endowments shall be used, among other objects, in giving exhibitions to encourage a longer stay at the school with a view to the study of specific subjects.

8220. Does your Commission propose to make the teaching of science compulsory in all endowed schools?—Yes; in all endowed schools we introduce into every scheme physical science as a necessary subject.

8221. Do you include in the term endowed schools such elementary schools as are endowed?—Not so directly; we do not insist upon physical science as a matter of course, but we include it amongst those subjects to which the endowment may be applied, and we say expressly, in fact, that one of the uses to which the endowment may be put, in an elementary school, is to provide apparatus or to assist in establishing lectures or lessons in natural science, as the circumstances of the locality may suggest. The difficulty that one foresees in providing for the teaching of science in all secondary schools is, who is to teach it, and even the introduction of a more scientific department into the existing training colleges would not remedy that deficiency. We must not look, I think, to the existing training colleges to supply teachers for secondary schools.

8222. Supposing a third year's course were, in general, added to the present two years' course at the training colleges, do you think that those who went through that third year's course would not be capable of undertaking the management of the science teaching?—I think they would. I think that some of the best men in the training colleges, even under the present circumstances, would be the very best men for the lower type of secondary school at all events. But when I say that we must not look to that, I think that, in the first place, the Education Department would very much object to pay for the training of those men for the purpose of elementary education, and then have them drawn off to secondary schools, more especially as the demand for the teachers of primary schools will be very great for some time, and will not be adequately met. It is desirable, if possible, to introduce into our secondary schools a somewhat higher class of teachers. I mean socially a higher class. The pupils in the training colleges are, in a great degree, taken from a lower grade of society than the pupils in secondary schools would be, and it is not desirable, perhaps, that



the teachers should, as a rule, be socially below the level of their pupils.

8223. Have any sources occurred to you from which the supply of such teachers could be drawn?—The establishment of training colleges in connexion with secondary schools has been suggested, and we have it under consideration, although we have not yet come to any definite conclusion. In that case, we should endeavour to apply any available endowment that we could put our hands upon to establish such a college, and, in such a college, we should provide for scientific instruction as a very prominent branch of study, and require that the students should be especially trained to teach science.

8224. Are there not a certain number of instances, at present, in which science is taught in secondary schools?—No doubt there are some, but I am afraid that it is the exception, at present, and not the rule, and I should greatly fear that it is not very thoroughly and efficiently taught; it is apt to be taught in a somewhat superficial and perfunctory way, very much through text books, for instance. A great many men who undertake to teach science are merely in the position themselves of having read up a certain amount of science, which they retail very much as they take it in, and, therefore, I think that, in order to have science thoroughly and efficiently taught, it would be necessary to devote a good deal of attention to the training of science teachers. It is not merely the knowledge of science that is sufficient, but they should be trained in the method of teaching. And even with regard to that subject, more than most subjects, I have great faith in the results of training teachers. I think the difference between a trained and an untrained teacher is very great, whatever be the subjects that he has to teach, but it appears to me that in teaching science the difference would be more especially observed. He ought to be able, not only to impart the knowledge, but he should be a good manipulator and know how to teach it practically and experimentally, and that can only be done by careful training.

8225. (*Sir J. P. Kay-Shuttleworth.*) And, likewise, it is important that he should be able to adapt his instruction to the various classes of minds that he may have to teach?—Quite so, and he ought to have got his knowledge, not simply from books, but from objects; his course of study ought to have been of a very experimental character.

8226. One of the chief difficulties in teaching being the adaptation of the teacher's mind to the minds of the scholars, which vary exceedingly in the different ranks of social life?—Yes, that kind of flexibility is almost a natural gift. In teaching pupils under training, one sees a marvellous difference between men of the same intellectual calibre. One man seems at once to be able to put himself *en rapport* with his pupils, and another, of equal attainments and equal general ability, can establish no relation between himself and them at all.

8227. At the same time, this kind of mechanical facility may be given to a man of average mind with respect to particular classes of his pupils?—Yes. An average man can, by training, be taught to impart a great deal of information.

8228. (*Chairman.*) Supposing that training colleges for secondary schools, such as you have been speaking of, could be established, do you think that an adequate supply of teachers could be turned out from them?—I should hope that a very considerable supply of teachers would grow up by degrees; it would open a new career to a good many young men. The establishment of exhibitions, in different secondary schools, for teachers at institutions of that kind, would induce many scholars, who have no very great career before them otherwise, to betake themselves to training colleges, and to become teachers. When such encouragement was given to masters in elementary schools, it led to a greater influx of pupils, and one may hope that it would be so in the case of secondary schools, when once the field was opened out.

8229. I think you stated to us, on a former occasion, that the Endowed Schools' Commissioners did not intend to lay down any very definite and precise rules as to the character of the science to be taught in secondary schools, but simply to state that certain branches of science must be taught, leaving it to the managers of the schools themselves to say which branches?—We felt that we must do that, because, in the first place, it will often be necessary for the managers of those schools to decide on what subjects shall be taught by the consideration of what subjects their teacher is able to teach; and local circumstances will also very often indicate what the subjects ought to be. We think it better, on the whole, that our schemes should not be too detailed and too minute in their directions, but should leave a good deal open to the judgment and experience of the governing bodies, hoping that they themselves will become more educated, as time goes on, and better able to meet the circumstances.

8230. Do you imagine that training colleges for secondary schools will be much more expensive than those for elementary schools?—They would, perhaps, be a little more costly if they were organized upon the same principles, that is to say, if they were institutions into which the students were received and boarded. It would be necessary to make arrangements for men of a somewhat superior class, and a little more in accordance with what they had been accustomed to. In the ordinary training colleges, the students, though they are young men of 18 and 20, herd together very much like school boys, they have no private studies, they occupy large rooms, which are class rooms, and they study altogether in a mass under the charge of monitors who enforce silence; and they have no access to their dormitories except when they are going to bed. Probably, in such training colleges, it would be necessary to give the students private studies, or to put two or three of them into one study.

8231. If the buildings were once provided, do you imagine that such colleges would be to any extent self supporting?—I think so, to a very considerable extent; because, if you consider the class who would use them, they would be better able to pay for their education, and I think they would, to a great extent, do so if it opened a fair career to them. They could always be assisted by exhibitions. I do not estimate that the necessary outlay in establishing those colleges would be greater than in the case of the present normal colleges on that account, because the difference of expense would be met by the capacity of the pupils to pay something themselves. In training colleges, at present, they pay little or nothing. During the time that our College at York was most prosperous, when we had 80 students, there was not a man in the whole College who paid a sixpence for his education; the Government paid every shilling. The average cost is probably 45*l.* or 50*l.* a head, and if, therefore, we could devote an endowment of, perhaps, 2,000*l.* a year to maintain a college which had good buildings, the students would be able to contribute the rest without any very great hardship. It would then be very much cheaper than an University education, or even than many other professional, educations.

8232. (*Dr. Sharpey.*) Do you consider it essential, or very material, that the students should reside in the College?—My own experience of the Training College that I had to do with would induce me to say yes; but, looking at the different type of students, I should say that it would not be so material in this case as in the other case. I think that they might be more safely allowed to live in lodgings and attend lectures; in that case, the college, of course, being placed in some town where accommodation could be found for them.

8233. (*Sir J. P. Kay-Shuttleworth.*) In coming to that conclusion, I apprehend that you conceive that they would be of a riper age and of a higher station in society, as you have already said, and of somewhat

*Rev. Canon Robinson, M.A.*

9 May 1871.



Rev. Canon  
Robinson, M.A.

9 May 1871.

more experience of life?—They would have more experience of life, and probably a little more self control, and, although not older in years, they would be older in habits and experience; I imagine that they would be about the same age as the students at training colleges, from 17 or 18 to 20, but the students in a training college at 18 are sometimes not so advanced or so experienced or so manly as an Eton or Harrow boy of 16; they have not much more power of taking care of themselves and keeping out of mischief than boys of 15 or 16.

8234. Would your experience confirm the evidence which the Commission has received concerning the very large amount of moral success which has been attained by the training colleges in the future lives and conduct of the young men who have passed through them?—I should say so to a very great extent; I do not, of course, know what testimony you have received, or how far it has gone, but my own testimony would go a considerable way in that direction.

8235. The testimony which the Commission has received has amounted to this, that the amount of failure has been so small that it is scarcely appreciable?—Something will depend upon the circumstances of each individual training college. When there are many training colleges, no doubt, one will have an advantage over all the others from situation and prestige, and will have the pick of the students, such a college, for instance, as St. Mark's, which, both from its being one of the first established, could always draw the cream of the students, and did so, and so did Battersea in its best days. I have no doubt that they have very few men of a decidedly inferior type, but we were not so fortunate as that in the provincial schools. We were obliged to take in a certain number of men who were not very much in sympathy with their calling, who were morally and mentally of rather a coarse fibre, and those men did not always turn out so satisfactorily as one could wish, but still they were in a minority, and a very considerable number of men who came under my observation became excellent schoolmasters, and I believe thoroughly earnest and admirable men in many ways. In fact, I could point to a great many of my old pupils who have pressed on from one point to another until they have obtained very considerable positions. Those form a very large and an increasing number. I constantly hear of fresh cases of such students who take their degrees in London, and a certain number have gone into the church, and others, some of the very best of them, have worked on from the day that I sent them out, 10 years ago, to the present day, in the same school without changing, which is, perhaps, as good evidence of a man's character and stability as can be given.

8236. Therefore, if there were no insurmountable difficulties to its accomplishment, your preference would be decidedly given in favour of the same corporate system of discipline and training of scientific students as obtains with respect to the students at elementary training colleges?—I should prefer it, with some modification adapted to the class. Even in our Training College, if it had been possible, I should have liked to have introduced a little more of what we call the University element, as regards the habit of life, and not to have had it quite so gregarious, to have given the men a little more isolation. It is, of course, a matter of finance to some extent; you could not give each man his separate study, but I should have liked to have done it. The defect of the system was, what I call, its extremely gregarious character. The men were always more or less living in a small crowd, but if it could be modified or remedied, I think it might be made a very healthy and beneficial system.

8237. My question had reference, not to that peculiarity so much as to the influence upon the principles, the mental character, and the development of the moral qualities of the student, at the same time that the highest intellectual qualification consistent with the object of his training was also obtained?—That, of course, is of very leading importance, and may be

turned to very great account, and I think it is capable of being applied, if not equally, almost equally, under the two systems.

8238. (*Professor Huxley.*) I apprehend that when you speak of the gregariousness of those students, you mean to imply that the habit of keeping them constantly under superintendence rather diminished their self-reliance and the power of acting for themselves?—I think it did. We had to deal with young men of 18, 19, and 20 very much as you deal with school boys of 13 or 14, imposing rigid silence during study hours, and massing them all together in large bodies for study. We could hardly ever give them an opportunity of being alone. Until a man went to his bedroom at night, and after he left it in the morning, he was never alone at all.

8239. When those young men were subsequently turned out into the world, they must have been exceedingly deficient in that knowledge of the world which, in point of fact, even an Eton schoolboy gets?—They were no doubt to a very great extent deficient in the knowledge of the world, not only from the two years which they spent in the training college, but from the character of their life before. A pupil-teacher's life, his five years of apprenticeship in a school from the age of 13 to 18, gives him a very limited sphere of observation. As soon as he begins to think at all, he begins to feel that his only work is to teach, and he gets into a kind of mechanical way of looking at almost everything as it bears upon his calling; first as a pupil teacher, then as a student, and afterwards as a schoolmaster.

8240. Do you think that that in any degree accounts for what everybody has noticed who has had much to do with schoolmasters of the class you refer to, who are, of course, in many ways excellent and estimable persons, what I may call the pedagogic habit of mind, their being absolutely certain about everything, and exceedingly confident as to their own knowledge, and the precision and accuracy of it; do you think that this training has anything to do with that?—I think it is very possible, it is almost inevitable.

8241. In your experience, does something of that kind characterise schoolmasters very largely?—There is some tendency of that kind, no doubt. When a boy begins to teach at the age of 13, and is accustomed to have what he says received by a class of boys, as a matter of course, he naturally comes to state opinions without thinking it necessary to give reasons for them, or even to see that there are reasons for them.

8242. (*Sir J. P. Kay-Shuttleworth.*) It is the general tendency, is it not, of the schoolmaster's profession?—It is inevitable.

8243. And, also, when the amount of instruction is itself very limited, the capacities of the students are, of course, only developed to a limited extent?—Yes. And another phase of the same thing is, that they are too apt to come to look at all knowledge merely as a thing which they are to teach again.

8244. (*Professor Huxley.*) Do you think that living in lodgings, under proper regulations, would tend to correct that evil tendency of the training in training colleges?—I think that it would have the advantage that I referred to just now, of giving a man more privacy and isolation, and enabling him more decidedly to choose his own associates from some congeniality of feeling and of mind.

8245. Would it not, at the same time, give a young man the habit of taking care of himself and not being so very helpless, as young men brought up under incessant supervision during the two most active years of their lives commonly are?—Yes, it would probably have that effect also. They would have, to a certain extent, to provide for themselves, and make arrangements for their own living.

8246. (*Sir J. P. Kay-Shuttleworth.*) Are you quite sure that there is a balance of advantages and disadvantages. On the one hand, we have had evidence from, as you say, a training college placed in the best position for the reception of students, that the amount of moral failure has been almost inappreciable,



and, generally speaking, I think, I may say, that if we were to examine the Principals of our Training Colleges we should find the amount of moral failure to be but small?—I think so.

8247. Taking that into account, and the fact that the teaching class is prepared, in its subordinate relations, to act again in charge of scholars under some supervision, do you think that the balance of advantages would not be on the side of the disciplinary training and residence in a college rather than of a residence in lodgings?—It would depend very much upon how much discipline you could bring to bear upon the students in lodgings. As you are aware, in the Universities it is possible to apply as much discipline to a student who is in lodgings as to a student who is in college, and I think that the Principal of a Training College might see as much of those students who were in lodgings, and require them as strictly to conform to certain rules as if he had them all within the walls of the building; and, if that could be done, I think the advantage might be on the side of lodgings.

8248. Would you be so kind as to state to the Commission what is the modification of the system of living in licensed lodgings which you conceive might be adopted, and which would approach somewhat to the discipline of a training college?—My view would be this, that students might, without much loss to the good effect of discipline, be allowed to live in private lodgings if those lodgings were in some way licensed and under the direct supervision of the authorities of the college, it being understood that if any breach of discipline were encouraged in connexion with the lodging house, the license would be withdrawn, that students so lodging should be required to present themselves at the college at certain times, not only to receive instruction, but to partake, say, in any common religious service (if there were a chapel, that they should be required to attend the chapel); and they should also be brought in contact, in other ways, with the Principal; and if the college provided a common hall, it would be an advantage that they should dine in the common hall.

8249. The difference consisting in their lodging in a licensed house, subject to the discipline of the College, but not necessarily forming a part of it?—Just so; pursuing their own studies privately, and master of their own hours within certain limits, but constantly brought within the College influences by being made partakers of some common life.

8250. (*Chairman.*) Do you think that such a system would work in London, for instance, or in any other very large town?—I think it might be made to work in any large town.

8251. (*Professor Huxley.*) You have told us, have you not, that the Endowed Schools' Commissioners are prepared to enforce the teaching of physical science in all the schools under their superintendence?—Yes.

8252. May I ask what is meant by the teaching of science. Do you insist that the teaching should be made practical?—We do not go further, and we hardly see how we can go further, than to introduce science into the programme of the studies as one of the necessary subjects. It must rest with the governors of the school what subjects shall be taught, and it would be their duty also to see that they are taught soundly and efficiently.

8253. I ask the question, because I think it would make all the difference in the world to the satisfaction of persons interested in the teaching of science whether that condition was insisted on or not. There are a great many of us who have a very strong interest in the progress of scientific teaching, and who would look upon the mere book teaching of science as almost as bad as nothing at all, and that such teaching would be wholly devoid of the disciplinary uses of science in education; you leave that point, you say, to the governors?—It is in fact left to the governors, and we do not see how we could do

otherwise, without prescribing by the scheme more than we think a body like ours ought to prescribe.

8254. (*Chairman.*) Although you do not prescribe the practical studies in experimental physics and chemistry, you have the power, and you would be glad to exercise it upon the application of the governors with a view to the erection of laboratories, and the provision of apparatus?—We give that permission in the scheme.

8255. (*Professor Huxley.*) Inasmuch as laboratories are requisite for anything like a thorough practical teaching of even the most elementary science, and as the governors could hardly build such laboratories without your sanction, do you think it fair to sanction the application of the funds of the schools to building laboratories in all cases in which you insist upon the teaching of science?—With regard to that, I ought to observe that our power over a school is a purely transitory one. It merely exists while we are preparing a scheme for it, and when the scheme is made, then we cease to have any further jurisdiction. Therefore, all the power that we give the governors we must give them by the scheme. We provide, as I said before, for a certain course of instruction; we provide, where there is immediate necessity for it, for the erection of new buildings; and we introduce a clause pointing to the disposal of the surplus endowment, which authorises the trustees to apply it for any object which may be for the advantage of the school, scientific apparatus or otherwise. So that, there is in each scheme a permanent standing clause under which the trustees would be able to apply any funds at their disposal to provide any kind of scientific apparatus that was necessary, and if they wished to build laboratories, of course they would be able to do so under the same clause.

8256. But would not the powers which enable you to insist upon every school teaching science, enable you to insist upon their finding proper appliances for the teaching?—We could no doubt do so. But if we leave the question of what branch of science is to be taught open, we can hardly insist upon any special kind of building being erected or any particular arrangement being made; that must be open too.

8257. You have not thought it, then, desirable to insist upon a particular kind of scientific teaching in your schemes, or upon the foundations of the scientific teaching being laid in a particular way?—We have hardly felt it within our province, in the first place, to prescribe what branches shall be taught in any particular school. It must be guided very much by circumstances of which persons locally connected with any school are generally the better judges. And, as to the mode of teaching, that seems rather to belong to those who have to manage the schools and who have to teach the subjects.

8258. Many persons who are interested in the teaching of science are strongly of opinion that there is a certain amount, a kind of elementary scientific teaching, which is the foundation of all scientific teaching, and that no difference of circumstances can make that more desirable in one place than it is in another, and I was going upon that idea when I put the question to you, because if the Endowed Schools' Commissioners had the same feeling they would have felt themselves empowered, I presume, to insist upon that particular kind of essential elementary science being invariably taught, and to insist upon the appliances for such teaching?—Perhaps, I ought to say that our Commission does not consist of men who have any practical knowledge of science teaching. We should not certainly feel ourselves competent to prescribe with any minuteness of detail, either what science ought to be taught or how it ought to be taught, but I think that very great service might be done if any body of persons who were competent to express an authoritative opinion could put out something by way of instruction to those schools when they get their schemes.

8259. But then, unfortunately, it would be optional on the part of the trustees to adopt it or not; it would not come with the authority of the Commission,

*Rev. Canon Robinson, M.A.*

9 May 1871.



Rev. Canon J.  
Robinson, M.A.

9 May 1871.

whereas at present, I apprehend, the Commissioners have the power of insisting upon this, that, or the other mode of instruction being carried out?—No doubt we could insist, for instance, absolutely that chemistry should be taught in every school, and we could insist that every lesson should be given experimentally; but, as I said before, we hardly feel justified in imposing upon any school those special restrictions.

8260. But, if you had felt yourselves to have sufficient reason for believing that it was proper to teach the elements of physics and chemistry, we will say, as the foundation of all physical science whatever, I presume that you have the power to insist upon those parts of elementary science being taught, and upon the provision of appliances for the practical teaching of those elements?—If I understand you right, if we were satisfied that those branches must be taught as the foundation of all more advanced teaching of science, then, whatever else we required, or whatever else we allowed to be an open question, we might impose the teaching of those branches absolutely in all cases. We certainly have power to do so; but I could not say now whether, if it were brought distinctly home to us, we should at once act upon it.

8261. If it were clear to you that that was the proper thing to be done, as it is clear to you that certain branches of mathematics should be taught, you would be able to insist upon it?—Quite so. I may say, also, that any representation made to us by competent persons on that point would be very carefully considered by us, and we should be glad to receive suggestions on any such points.

8262. Have you any funds at your disposal which might be employed, supposing you were inclined to employ them, in the shape of exhibitions for students in training colleges for science, supposing that such training colleges existed?—Yes, the funds of any or all endowed schools might be used for that amongst other objects; and, in fact, the tenor of all our schemes is such, that it would be always in the power of the managers to apply them, or some of them, to that object, for we found in every school, or at all events we give the power to the governors of founding, exhibitions, and we make those exhibitions tenable at any place of literary or scientific study which may be selected by the students and approved by the governors. So that, if a boy in an ordinary endowed school gets an exhibition of 20*l.* or 30*l.*, and elects to go into a science college, there is nothing to hinder him.

8263. Supposing the Government were to establish a science training college, I presume that it would be a fair thing to expect the endowed schools to pay for the training of their own science masters in that college, and that would afford the machinery by which it might be done, I presume?—Yes.

8264. There would be nothing inconsistent with the powers of the Commissioners, supposing they were inclined to do so, in carrying out such a scheme of that kind?—It would be quite within our power in any endowed school to fasten an exhibition upon science which would have the effect which you refer to. And, no doubt, in some cases we shall, where the funds are considerable, absolutely assign some portion of them expressly to science.

8265. Do you at present make any exhibitions in schools tenable at places of instruction which the trustees may select?—In all cases. I think every scheme that we have published has that provision, that the exhibitions shall be tenable at any place of scientific or professional study. We throw the exhibitions as widely open as possible. We consider that the condition would be fulfilled even if they were taken to a medical college or to an engineering school.

8266. You spoke of the difficulty that exists at present in the way of obtaining science teachers in the endowed schools; do not you think that that difficulty would disappear as soon as the demand is created, and young men see that they can get a living by some three years' training in a science college?—I think that the demand will sooner or later produce the supply; but there will be some interval during

which it will be difficult to find teachers sufficient in number to supply all the schools that are being reorganised; and, of course, we must anticipate that, in the transition stage, there would be a good deal of shallow superficial science teaching. But still the feeling that it must be taught will lead to greater efforts to have it taught well, I think, more particularly if science colleges are established, as there is some prospect of their being established, in different parts of the country. There is an effort being made to establish a science college in Yorkshire.

8267. (*Chairman.*) Those colleges will not be specially for the training of teachers?—No, they will not. They are intended to give instruction in science of every kind for professional and manufacturing objects. But I believe that the promoters of the Yorkshire Science College do contemplate a training department, which I think it is very desirable to have. The science teachers would be more efficiently taught in the science colleges, where there would be a much greater amount of machinery and apparatus for their instruction.

8268. More efficiently, you think, than at the special training colleges?—I think so, because there would be greater appliances. Training colleges would only be able to have a limited amount of apparatus, and to devote a limited amount of time to scientific study, because there would be a greater variety of subjects making a demand upon the attention of the students. It might be desirable, perhaps, in a complete and perfect system, that, after a teacher has been trained generally for the work of a schoolmaster, he should spend a certain time at an exclusively science college if he means to be a science teacher also.

8269. (*Professor Smith.*) Considering the great willingness which has been shown lately by the older Universities to admit men of very different stations in society, and also to give them an education adapted to their purposes and intentions in life, do you think that it might be possible to do something at the Universities for the teaching of the masters in secondary schools to whom you have referred?—I have sometime thought that the Universities might take up the subject of training teachers in some form or other by establishing a chair of *paedagogy*, but the difficulty would be in the practical part. It would be very easy to teach the theory of education and the theory of teaching at the Universities, but they would require practising schools and places where students could be put through all the manipulations of teaching.

8270. Then, it would be on account of the difficulty of providing a school for them to teach in, in fact for the purpose of practice; do you think that that would be the principal difficulty in the way of such a proposal?—It would be one difficulty, which might be overcome by the Universities either utilizing some of the local schools or establishing schools of their own.

8271. I should like to know if that is the main objection that you would entertain to such a proposal, or if you think there are others?—The question is one which I have not sufficiently thought out to be able to speak at once with very great confidence upon it. It seems a little departure from the ordinary and the direct objects of University life. The students who would be trained would hardly be able to enter into the same curriculum with the other students; they would be a class apart.

8272. Do you mean that the attainments which you would require for a teacher for a secondary school would be below those that are required at present for the pass degree for the Bachelor of Arts in either of the Universities?—They would be somewhat different. They would not, perhaps, be lower than what is sufficient to enable a man to pass, but they would be of a somewhat different character. They would be more modern and more general.

8273. But the requirements for the Bachelor of Arts Degree in the Universities are so rapidly assuming a more modern character, that I am not quite sure whether that difference would really continue very



long to exist?—I should like to see the experiment tried at the University.

8274. (*Sir J. P. Kay-Shuttleworth.*) Is it within your experience, that masters of grammar schools and other secondary schools, seeking assistants and selecting them very much by the standing of a young man in the University tripos, have found themselves grievously disappointed in his power of giving instruction in the school in consequence of his total want of method and skill in teaching?—Undoubtedly, in very many cases, I have heard complaints of that kind.

8275. What I apprehend you see is, that the University does not at present contain within it the means of correcting that defect of skill and supplying that power in the art of teaching which is essential to the success of a young man whatever his attainments may be?—The University makes no attempt to make men teachers, it aims at making them scholars, and the consequence is, that many very good scholars enter upon the work of teaching in the most perfect ignorance as to how they should go about it.

8276. So that if the principal or the master of an endowed school or a secondary school were to apply to the University for the man who had had the greatest success in the science tripos, he could, at present, have no assurance that he would be a good teacher?—None. The only evidence that he would have would be that the man had attainments which a teacher ought to have.

8277. (*Professor Smith.*) Is it not true that all the teachers, or nearly all the teachers, in the first grade schools in the country are derived from the Universities, and are chosen without any reference to their having received special training in the art of teaching, but simply with reference to the acquirements which they are believed to possess?—I believe it is the case. The reason why the schools of the highest grade do not select trained teachers is, because the trained teachers generally belong to a much lower class, and their attainments are attainments that are not generally available in the first grade schools.

8278. Do you hear complaints from the head masters of the great public schools in the country, that the young men whom they receive from Universities and whom they take from high positions in the pass lists and honours lists of the Universities give them much trouble, owing to their want of skill in teaching. I mean after the first half year, perhaps, or after a very short time?—I have not been sufficiently in contact with the head masters and the general masters of schools to be able to speak with any authority upon that point. I have heard such complaints. What has come more directly under my own observation is the impression which one gets from the pupils in public schools, as to the want of power of many young masters to maintain discipline. Even when they can impart the knowledge, the difficulty is to get boys to keep such good order that they will receive the knowledge.

8279. (*Sir J. P. Kay-Shuttleworth.*) Your experience will enable you to tell the Commission whether, seeing that certain of the masterships of endowed schools have been in the gift of the colleges, they have not often selected scholars of great eminence whose administration has been fatal to the school?—Certainly, my experience enables me to say that there have been such cases.

8280. (*Dr. Sharpey.*) Is it the case, in the existing training colleges, that board and residence is afforded gratuitously to the pupils, or does the college receive any payment for it?—The college receives payment and yet the education is, as far as regards the pupil, gratuitous. It is paid for by the Government, as a rule. The students in the training colleges compete for what are called Queen's scholarships, and those Queen's scholarships give free admission. In some cases now, under the Revised Code, I believe there is a small payment, of about 5*l.*, exacted from a certain

number of students; but with that exception there is no payment.

8281. In those science training colleges which you would contemplate for training teachers for the higher schools, would you propose that the maintenance of the students should be gratuitous?—Not altogether so. What occurs to me as being the proper course, is to provide a certain number of exhibitions open to competition, to encourage the managers of endowed schools to allow some of the exhibitions in connexion with their schools to be used in the same way, and to have a fixed fee for every student who goes to the college, but to allow him to reduce it by his exhibition if he can get one; so that, in most of those colleges, there would be a considerable number of students who were taught gratuitously by means of exhibitions attached to the college, some who brought exhibitions with them from other institutions, and others who paid the expenses of their own training.

8282. But, supposing that no provision were made in those colleges for the residence of students, the funds would go a longer way, would they not, in the establishment of such colleges than otherwise?—The outlay would be less if you were to throw the maintenance of the pupil upon himself, but if you make the exhibition of sufficient value to cover the cost of maintenance as well as the instruction, then I imagine that it would be quite as expensive to the college to keep students in lodgings as to keep them within the college walls.

8283. Except, that the original outlay for buildings would be less?—The outlay for the buildings, no doubt, would be less.

8284. (*Chairman.*) Are there any other points upon which you could give us any information?—With reference to the action of the Science and Art Department, the Science and Art Department I think has taken action in the matter of instruction in science since I ceased to be connected with the training schools; but it has occurred to me that very considerable encouragement might be given in the existing training colleges to the study of science, if the Science and Art Department, or the Educational Department either, would do for the training colleges what now the Revised Code does for schools, namely, make a supplemental grant for some specific subjects. The grant made by the Education Department to the training schools is paid in a lump, 100*l.* upon every pupil, who has been two years in the college, and who has been two years in charge of an elementary school, and obtained a certificate. That represents the general training of a pupil and the cost of it. If besides that there were a specific payment for as many students as acquitted themselves well in a scientific examination, the colleges might be induced to take up the study of science with more spirit, and if the syllabus were modified so that the second year was made a little more free for those higher subjects, and if the elementary and general subjects were limited more to the first year's course, I think that a good deal would be done, as far as elementary schools go, in elementary normal colleges to promote scientific study.

8285. Has the Science and Art Department any direct relations with the training colleges at present?—Yes, the training colleges are able to send in students to pass certain examinations in science, in physical geography, or inorganic chemistry, or physics. The Science and Art Department makes certain payments. I noted down the amount which had been paid in 1869 to all the colleges, and it was 341*l.* to 31 colleges, giving an average of about 11*l.* a piece. I do not understand the system sufficiently well to know what it is.

8286. You rather contemplate that more direct relations might be entered into between the Science and Art Department and the training colleges than exist at present?—Or, rather, I think it would be more in harmony with the general arrangements, if the Education Department did it—if it were paid out of the

*Rev. Canon Robinson, M.A.*

9 May 1871.



Rev. Canon  
Robinson, M.A.  
9 May 1871.

parliamentary grant which is applied to education directly to the training colleges, and if a college, in fact, were told that in addition to what they can at

present earn, if they are paid upon the results, they should also, upon producing certain scientific results, get additional payment.

The witness withdrew.

Adjourned to Friday next, at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Friday, 12th May 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. The MARQUIS OF LANSDOWNE.

Sir JOHN LUBBOCK, Bart., M.P., F.R.S.

Sir JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

BERNARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

Right Rev. J.  
Fraser, D.D.

12 May 1871.

The Right Rev. JAMES FRASER, D.D., Lord Bishop of Manchester, examined.

8287. (*Chairman.*) I believe your Lordship acted for some time as Diocesan Inspector in the Diocese of Salisbury?—Yes, and also in the Diocese of Oxford.

8288. Were there a considerable number of schools in your district?—No, it was a small area in each case, including, in Salisbury, I think, 15, and, in Berkshire, 18 parishes, with a corresponding number of schools. I have, however, a much wider experience of rural schools than that, because I was employed as Assistant Commissioner under the Duke of Newcastle's Commission of 1857–8, and, in the course of that inquiry, a specimen agricultural district was assigned to me, which included parts of the counties of Dorset, Somerset, Hereford, Worcester, and Devon. In the course of that inquiry, I visited very nearly 400 parishes, and about 400 schools. Some of them were town schools, in such towns as Dorchester, Crewkerne, Yeovil, and Hereford, but they were all of them agricultural towns, and the centres of an agricultural community, so that, in describing them, generally, I may say that they were rural schools.

8289. Was any considerable proportion of them also under Government inspection?—I should say, speaking roughly, about one-third of the whole number.

8290. Was not the Duke of Newcastle's Commission appointed considerably before the issue of what is commonly known by the name of the Revised Code?—They reported in 1861, before the issue of the Revised Code. I may add, that I have also acted as Assistant Commissioner under a more recent Commission in 1867, a commission to inquire into the employment of women and children in agriculture, especially with a view to their education, and, in the course of that inquiry, I saw a certain number of schools.

8291. A large number of the schools in the agricultural parishes were not, I believe, affected by the operation of the Revised Code?—Those that were not receiving Government aid, of course, were not at all affected by the Revised Code.

8292. I imagine that a very large proportion of the schools that you visited were not under Government inspection?—Probably two-thirds of them were not under Government inspection, and one-third was.

8293. Have you had any means of observing the effect of that Code?—Yes; I had an opportunity of observing it in the schools of my own parishes. I had the management of rural schools for nearly 25 years. I conducted one of those schools at one time under the old system, and subsequently under the new system, so that I have had an opportunity of comparing the two.

8294. Was any considerable change made in consequence of the issue of that Code?—Not as regards the management or instruction of the school.

8295. Was more education in the rudiments of science given previously?—Possibly there was in some

of the better schools, here and there. But, in speaking of the rudiments of science, I am not quite sure whether it was not under the influence of some prizes given by Miss [now Lady] Burdett Coutts for the promotion of knowledge in what were called common things, that an attempt was made, for a short time, to convey the rudiments of science into the minds of agricultural children. In the case of the mistress of my own school, I recommended her to go into Salisbury for an examination on that subject, and she gained the first prize, and that encouraged her to attempt to indoctrinate my rural children in Wiltshire with a little knowledge of the merest rudiments of science.

8296. You were also a considerable time, were you not, in America, acting as Assistant Commissioner?—I spent five months in America collecting information for the Schools' Inquiry Commissioners as to the system in the common schools of the United States and of Canada.

8297. Could you mention any of the results at which you have arrived, from your examination of the American schools, which you think might be available as suggestions for the improvement of elementary education in England?—I have summarised, in my Report, the points in which I think we might take some hints with advantage from the American schools, but those points have chiefly reference to the mode of their support, and to the gradation of schools. Those are very important points, but it is almost impossible to institute a comparison between the American system and ours, from the fact that the graduated system contemplates a child being under continuous instruction from the age of five to the age of 18, though, of course, children drop out of the system at any conceivable point in it. In New York, a very large proportion of the children never get beyond the primary schools, which would be analogous to our infant schools, and you may imagine the extent to which the dropping out to which I allude prevails, when I tell you that the total number of children in the schools of New York was something like 80,000, of which number, half, probably, may be assumed to be males, and yet the High School, the Academy as it was called, answering to the High School, through which nominally, in theory, every boy was expected to pass, only numbered about 800 boys. By the hypothesis of the American system, every child that enters school at five years of age is supposed to remain under instruction till 18. That is so entirely different from the facts with which you have to deal in elementary schools in England, that it is almost impossible to institute any comparison.

8298. Though that may be the theory, in reality a large number of them terminate their education at an earlier period?—Infinitely the larger proportion. School-attendance is determined by the same causes that determine the question here; that is to say, by the means



of the parents. If the parents can afford to dispense with the earnings of their children, they will let them run through the whole system, but as soon as the earnings of children are of importance to the parents, they take them out of the system, because there is no compulsion requiring the children to go through the whole course for the 13 years, which are implied by the theory.

8299. What do you say as to the knowledge of the children who leave the American schools, we will say at 13 or 14, as compared with English children of the same age. Is the proportion about the same as in the majority of the elementary schools in England?—My general impression is, as I have stated in my Report, and I think it is an impression which was shared by most of the intelligent and far-sighted educators in America, by such gentlemen as Mr. Philbrick, the Superintendent of the Boston schools, that their system is infinitely too multifarious in its range, and includes too many subjects, and that, as a consequence, the children leave school with a certain smattering of knowledge spread over a very large space, but with very little accurate acquaintance of any subject. The complaint that I heard constantly made was, that important subjects got crowded out; that the programme was so wide that one subject thrust out another. It seems to be the ambition of the American parent that his children should know a little of everything, and the consequence is, that they know very little of anything thoroughly well. In the Boston schools themselves I found a very strong desire prevailing (I do not know how far it has been carried out) to contract the programme rather than to extend it. If you were to refer to my Report and see what the programme of subjects is that a teacher in a high school, or a grammar school, in America, is expected to teach his children, you will see that it contains almost every knowable thing. Of course, it is not realized, but that is the theory.

8300. (*Sir J. P. Kay-Shuttleworth.*) Your Lordship's experience has first been personally in the management of your own parochial school, then as Diocesan Inspector, and then as Assistant Commissioner to the Duke of Newcastle's Commission over a wide area in the West of England?—Yes, and subsequently as Assistant Commissioner under the more recent Commission to inquire into the condition of women and children in agriculture, specially with a view to their education.

8301. (*Chairman.*) Is that Commission still sitting?—They have reported two or three times, but I think they have not yet published their final Report and Recommendations. It is a Commission of two only—Mr. Carleton Tufnell and Mr. Seymour Tremanheere.

8302. (*Sir J. P. Kay-Shuttleworth.*) You have had to consider the condition of elementary education in America, and have reflected and reported upon all those subjects. Assuming that there will be an increase in the efficiency of elementary teaching, and assuming also that, by the operation of the compulsory clauses, the attendance of the children will be more regular, and will be prolonged to a later age than it is at present, and that the appliances of the school will be improved; assuming all those things, have you formed a conception of what will become the proper subjects for instruction to children in agricultural districts in an elementary school up to the age of 13?—Your assumptions are so very wide that they have gone a great way ahead of the present condition of things, and I have hardly formed a conception of what would be the proper course of instruction under such an improved state of things. You have assumed the greater efficiency of the teachers, and I do not see the way at present to that. You have assumed a very efficient system of compulsion; I do not see the way even to that at present. I should be very glad if both these improvements could be effected; but until they are, it is very difficult to form one's conception of the proper subjects for instruction to children in agricultural districts upon any different basis from that which exists at present.

8303. Taking any schools which have most nearly fulfilled those conditions in agricultural parishes, you have had before you in them examples of a greater degree of success than has been on the average obtained. May not this success enable you to arrive at such a conception?—I have seen two rural schools, and a third school, which was in the city of Hereford, which might almost be called a rural school, both of which certainly were remarkable schools, and which owed their success entirely to exceptional causes. One was the school at King's Somborne in Hampshire, which was brought into a condition of remarkable efficiency by the late Dean of Hereford. Another was the school at Abbott's-Ann, under the management of the Honourable and Reverend Samuel Best, which was a direct off-shoot of the King's Somborne School, and locally situated in its neighbourhood; and the other was the Bluecoat School in Hereford, which was watched over with great care by Dean Dawes, and upon which I remember that I reported, and in a note to my Report to the Duke of Newcastle's Commission, I said that I heard a lecture given by the head master to his first class, I think it was upon flame, or some common subject of that kind involving scientific principles, which was given with remarkable intelligence, and which I think every child in the class certainly appreciated. I have heard also of a very remarkable school in Suffolk, under Professor Henslow, the late Professor of Botany at Cambridge, in which I am told that botany was made to play the same part in the education of children that grammar or arithmetic plays in other schools; but I consider that the success of those schools was entirely owing to the special influences and advantages which they enjoyed. The King's Somborne School, which had reached a very high pitch of pre-eminence among other rural schools under Dean Dawes, I have not visited since, but I understand that it has lapsed under the present management into the normal condition of a rural school, neither better nor worse. The Abbott's-Ann School is probably much in the same condition that it was, because Mr. Best is still watching over it. The condition of the Bluecoat School at Hereford I cannot now say anything about.

8304. With respect to King's Somborne, is it within your knowledge to what extent Dean Dawes himself personally taught in the school in the early period of its history?—I believe throughout his residence there the school was impregnated with his personal influence, that he directed the whole course of study, and that he taught in it very largely.

8305. And also probably he taught the master?—Yes, he taught the master, and, to the best of my recollection, his master had not been at a training school. I am not quite certain upon that point, but to the best of my recollection the master had been entirely trained by Dean Dawes.

8306. At the time that you visited it, from what classes were the scholars drawn?—They were drawn from all classes. In that respect, it was as nearly as possible a reproduction of the American common school. I do not think that there were any gentry resident in the parish; it was a parish, if I remember rightly, with a population of about 1,000, consisting entirely of tenant farmers, agricultural labourers, and the ordinary classes of village tradesmen and mechanics; and, I believe, the children of all those classes frequented the school.

8307. Was that also the case with respect to Mr. Best's school?—Yes. I may add that I know more of that, because I resided within seven miles of Mr. Best's school, and I often heard it spoken of. I believe that Mr. Best's school, from its excellence, drew several children even from the town of Andover, which was two or three miles distant.

8308. Belonging to what class?—I should think belonging to the class of small tradesmen, or people who had sufficient intelligence to appreciate a good education for their children.

*Right Rev. J. Fraser, D.D.*

12 May 1871.



Right Rev. J.  
Fraser, D.D.  
—  
12 May 1871.

8309. To what classes did the scholars of the Bluecoat School at Hereford belong?—I believe, as its name implies, that they were of the working classes; it was an ordinary endowed charity school.

8310. Were they boarded and lodged?—I think not; I believe they were day scholars. There was nothing special about the Bluecoat School beyond the general high average of intelligence among the children. I merely remember noticing in my Report, in a footnote, that I had heard a lesson given upon some subject of physical science which seemed to me to be fully appreciated by the children, but the extent to which rudimentary instruction in physical science was given in that school I am not prepared to state.

8311. Can you state, with respect to Mr. Best's school, the extent of instruction in physical science?—I do not think they have a laboratory, but they have chemical apparatus there; and I believe the scholars are taught a little elementary chemistry. There was also apparatus for teaching physical geography and the principles of astronomy; and these are probably the main subjects of a scientific character which are taught there.

8312. Looking to the schools which are receiving annual grants from the Committee of Council, and are taught by certificated masters, with the usual proportion of trained pupil teachers, have you any expectation that, without the special advantage of such men as Mr. Best or Dean Dawes, it would be easy to secure even the same amount of success in teaching physical science in those schools as was accomplished by Mr. Best and Dean Dawes?—I should think it almost impossible without corresponding efficiency and interest in the management. I look upon the success of the schools which I have mentioned as entirely due to the personal influence in the one case of Dean Dawes, and in the other case of Mr. Best.

8313. Taking an efficient elementary school with the best trained certificated masters and the usual amount of assistance from pupil teachers or assistant masters, what would you think would be the proper subjects of instruction, and to what extent do you think that instruction in physical science could be introduced up to the age of 13 or 14?—Speaking of rural districts, unless one can hope to retain children to later period in life than they are generally retained now, —11 or 12 is quite the extent, and in fact in my Report to the Duke of Newcastle I said 10 or 11; but even if you could keep them at school till 13, I do not think that with any educational advantage could you extend the programme of study much, if at all, beyond what it is now. No doubt the subjects that are taught at present may be taught with a great deal more intelligence and be utilized more effectively as educational instruments, so that a child at 13 may leave school with a much more developed understanding and much greater capacity of fastening his mind upon any subject to which it may afterwards be directed than is the case at present; but I do not think that in the interest of education, in the sense of developing what mental power a child possesses, you will gain anything by adding to the present programme of instruction.

8314. Taking the subject of physical geography in its widest sense, you would think, probably, that considerable advancement could be made in a more logical teaching of physical geography than exists at present?—That varies very much in different schools. I think that in the best class of rural schools now geography is taught in a fairly intelligent manner. I remember in my own school my children could have told you the cause of the changes of day and night, and what it is that produces the changes of the seasons, and they had some notions of such physical facts as the relative distance of the sun and moon. I recollect particularly on one occasion an itinerant lecturer came to give a lecture to my children, and the first two classes were admitted. The man had got a number of diagrams illustrating astronomical phenomena, but he confounded the diameter of the moon with its distance from the earth, and he made the moon 2,000 miles from the earth. The children asked me the next morning

whether the man was right, as they thought that I had told them something very different from that.

8315. Would they understand such phenomena as the tides?—They had intelligence enough to understand it, if it had been properly explained.

8316. But any improvement which could be made in extending a knowledge of physical geography, so as to give a better acquaintance even with the main features of geology, with such phenomena as those of the tides, you would not object to, as falling outside the legitimate province of efficient elementary teaching?—Certainly not; anything that would enable teachers to teach what they now teach with more intelligence, and as instruments of greater mental development, I think would be extremely desirable, but it must be taught, remembering the age of our children, more in a concrete than in an abstract form. We know that abstract principles are not particularly interesting to young children of 10 or 11, and though, in learning, children are obliged to swallow a great deal of knowledge which they cannot pretend to understand when they receive it, such as the rules of arithmetic, and things of that kind, yet without going in for Pestalozzianism pure and simple, evidently there are limits to the extent of the abstract principles that you can expect children to lay hold of.

8317. Do you think anything may be done in laying a foundation for instruction in physical science, take, for example, chemistry, in an agricultural district?—I know very little of chemistry myself, but I should have thought that you could not attempt to teach much chemistry without an expensive apparatus and more or less of a laboratory. There is considerable difficulty experienced at present in supplying schools with adequate apparatus, and I do not imagine that without it very much progress can be made in chemistry. Certainly it would be a branch of study very likely to interest children, as it deals so largely in experiments.

8318. Would you go much beyond the explanation of certain natural objects and phenomena, such as the constitution of air and of water, and the phenomena of the respiration of plants and animals as connected with chemistry, or would you enter into chemical nomenclature and the chemical constitution of other objects not connected with natural phenomena?—I should certainly not enter into chemical nomenclature, or the doctrine of equivalents, and things of that kind. I am presupposing the case of children under 13 years of age.

8319. Taking such a subject as botany and the sciences of observation generally, do you think that progress could be made in them up to that age?—I have already mentioned an instance, not within my own knowledge, but of which I presume the Commissioners have heard, namely, Professor Henslow's school in Suffolk, in which botany was used as an instrument, I believe, with very great success, in developing the intelligence of the children; but I think that that was used in substitution for other instruments which possibly might have been employed with the same amount of success. I do not know at all whether that school has turned out a great number of botanists, or whether the knowledge has been retained.

8320. With respect to America, in which very ambitious efforts have been made to introduce with more or less skill instruction in the elements of physical and natural science, what is the impression which your observation and the information which you obtained from the most observant persons there, have left upon your mind as to the value of that extension of the objects of instruction in elementary schools?—My own opinion of it was that it was mischievous, and I think that is also the opinion of the best advised educators in America, particularly of Mr. Philbrick, who is the Superintendent of the schools at Boston; they were contemplating a contraction of their programme at Boston when I was there.

8321. You previously stated, that one of the defects of the system was that sufficiently exact knowledge was not obtained?—I think that is the result of it, or,



rather, that a sufficiently exact knowledge is not retained; the forces of the mind get dissipated, and the pupil has not learned how to acquire exact knowledge afterwards in any subject; in fact, the system produces a disinclination to take up any subject with the view of accurate knowledge. The ambition has been to cover a very wide field, with the result of acquiring only an imperfect amount of information in any one subject or topic which has been attended to.

8322. The most useful habits of mental application have not been acquired in the first instance, and the mind, likewise, has not been trained to an accurate classification and retention of the subjects of study?—I think not.

8323. You would conceive it wise to select the subjects of study in some degree with a view to their effect in training the best habits of thought and application, and the retention of what is learnt?—That is my idea of education.

8324. Is there anything in America which would lead you to suggest an improvement in our schools as a means of preparation for a degree of scientific knowledge which can be acquired in an education secondary to the elementary school, that is to say, whether it is desirable that anything should be introduced into our system which would lead up from elementary schools to scientific instruction in the secondary schools?—I think it is extremely desirable that there should be institutions, such as, at one time, it was hoped that our mechanics' institutes and schools connected with them would be, by which, after the elementary process is gone through, any aptitude which might belong to individual men or women might be developed, and any special knowledge that they indicated a natural taste for acquiring might be acquired.

8325. Do you think that any solid foundation is laid in the elementary schools of America for the future scientific studies of those secondary schools?—I think that the instruction in the primary schools in America lays a sufficiently solid foundation; it is in the secondary stage that they break down. Their programme in the primary schools is very narrow indeed, but it is thoroughly well taught; the mischief begins in the grammar schools.

8326. At what age does the primary school cease?—About eight or nine; they enter at five, and there are generally six classes, each class occupying a term of six months, and when the children have passed through these, they would then be of an age to pass into the second grade.

8327. The secondary school commences at eight, at what time does it terminate?—At 13 or 14. They move up by examination from grade to grade. If a child takes his steps at a lower age he might move on more rapidly, but, generally speaking, it would be at 13 or 14.

8328. Up to the age of 13, can anything be done in what we call an elementary school which would prepare for the scientific classes that are taught, or that are hoped to be taught, in mechanics' institutions and evening schools, or in any other form of school succeeding to our elementary schools?—I think the instruments which are employed at present, if thoroughly well used, would be quite sufficient for the purpose of laying a foundation for teaching a boy or a girl at the age of 14 or 15 how to use his or her mental powers, which I take it is the great work of education in that stage.

8329. You would not think it necessary to introduce abstract scientific instruction in a school which is attended by scholars up to the age of 14, as a preparation for any succeeding instruction in science?—No, not beyond the stages to which I have already referred, making, for instance, the geographical instruction thoroughly sound and intelligent.

8330. (*Professor Huxley.*) Have you considered what may be done by well-managed infant schools, before the age of six or seven, in the way of saving time, to be devoted to elementary subjects subsequently in elementary schools?—I am not quite sure whether

your question has special reference to rural or urban schools, but in both there is very great difficulty in the way of infant schools, as the Commission must be aware. In the first place, a very large proportion of our rural parishes are parishes with a population under 400, and, in such parishes, it is impossible to have a double organization, an infant school and a secondary school; and even if you had it, the distance which the children have to travel is so considerable that you cannot get children much under six years of age to come to school; if you get them at an earlier age, they generally come when they have an elder brother or sister to bring them; but if you have to send them to two different schools, in two different parts of the parish, you would not get the infants at all. In my parish in Berkshire, the two parts were separated by a river, and one great difficulty to be encountered was the mothers' fears lest their children should fall into it. One child did tumble into the lock and was drowned, and that, for a time, was the cause of great alarm on the part of the parents. Then, in large towns, like Manchester or London, there is great danger in young children crossing crowded streets, unless they are under protection. You are aware that this point of infant schools was one to which the Duke of Newcastle's Commission particularly directed public attention. They thought that the existing system was deficient in its mode of treating children under the age of seven, and they particularly directed attention to the importance of improving the efficiency of infant schools. If it were not for those physical difficulties which I have alluded to, I should quite admit that a great deal more might be done with children under the age of seven than is done; but, on the other hand, there is an opinion which is very largely prevalent that it is not altogether wise, with a view to the future mental development of the children, to force their intellects prematurely. I noticed, with a good deal of interest, the other day, that Miss Lydia Becker, at Manchester, had been writing some letters in the public papers to the effect that she has found that she could teach a child to read fluently in an ordinary book in the English language within a period little exceeding six months, and this was a child between the age of four and five. I, therefore, do think, that just as in our public schools we wasted too much time upon our Latin and Greek, so, with more efficient methods of instruction, very much more rapid progress may be made in getting over those first difficulties, which are very discouraging to young children at present.

8331. You are doubtless aware that in many of the most crowded parts of London there are very large infant schools, and that, in the east end of London, the infant school system is developed very largely indeed, and with great success?—Yes, I am aware of that.

8332. As bearing upon our inquiry, the principal argument against introducing scientific teaching in elementary schools is, the time of the children would be taken up with the more elementary matters; if those elementary matters could be got over, to the extent even of the first stage of the Revised Code, there would be so much time gained for other matters, would there not?—Yes.

8333. I think there is a very common feeling that those who wish to introduce physical science into elementary schools mean something very grand and abstract and gigantic, and, perhaps, that is rather owing to the fact that one has not a less imposing name for the teaching which is really desired. I take it that those persons who wish to introduce physical science really mean an elementary acquaintance with the phenomena of nature, and with plain and obvious natural laws, which may be made intelligible even to children, and I should be glad to know whether you are acquainted with a German work, "*Sandmeier's Lehrbuch der Natur Kunde*"?—No, I am not.

8334. The method which is recommended therein, is a threefold course, each course going over two years; a child's school life beginning at seven, the course would be from seven to nine, nine to eleven, and

*Right Rev. J. Fraser, D.D.*

12 May 1871.



Right Rev. J.  
Fraser, D.D.

21 May 1871.

eleven to thirteen, and there is instruction in, what is strictly speaking, physical science, but perfectly adapted to the minds of children for each of those periods?—And that instruction, I presume, proceeding upon a thoroughly well-methodised system. You will probably remember, that, some 14 or 15 years ago, in consequence of a stimulus given by Miss [now Lady] Burdett Coutts by some prizes which she offered, there was a great talk about knowledge in common things, and there was a book brought out at that time by Doctor Brewer, among others, which, probably, you may have heard of, I think it was called “Knowledge of Common Things,” and that book was put upon the list of the Committee of Council, and for some time, certainly made its way into a considerable number of schools; but I do not think it approved itself to scientific men generally, at any rate the thing has died out, and, I believe, the book also has disappeared.

8335. The contrast between a book of that kind and the system to which I am now referring is, that the “Knowledge of Common Things” had reference entirely to practical purposes; there was no means taken to lead the mind of a child to what may be called purely scientific considerations; the design of that education was pure information, no attempt was made to use the information, that was the cardinal defect, was it not, of the whole system, considered educationally?—Yes, that was so.

8336. But in the system to which I am now referring, although the matters brought before the child's mind are entirely elementary, and confined to such topics as any child can understand, yet the thing is so arranged that the child becomes acquainted with natural phenomena in a scientific way, and is led up to a higher step of information afterwards. I presume you would see no objection to a system of that kind?—Certainly I think it would be extremely desirable, provided that it did not take too extensive a range. It seems to me that in rural schools any simple scientific explanation which would interest children, whose faculties of observation are generally tolerably keen, and who really like to know the why and the wherefore of things within the range of their observation, would be a very valuable element of instruction.

8337. Sandmeier's book is specially intended for a village school in Switzerland. The first lesson is on a primrose: the children are instructed to bring a primrose with them to school, and there is a most admirable lesson upon it, which is perfectly intelligible to every child; and things of the same kind are taken, so that, by degrees, the child's mind is opened to a sort of conception, of course very rough and rudimentary, but still a conception of the whole circle of the phenomena of nature?—I can fancy that in your hands such a lecture might be extremely interesting and extremely instructive to children; but does it not rather require a high order of scientific knowledge on the part of the teacher to give such a lesson? In America I found that there were text books in use, not, I should imagine, of so high an order as this which you refer to, but of the same kind as that book of Doctor Brewer's; but it was admitted as a thing of frequent occurrence in schools that the teacher was very often not more than three or four pages ahead of the class.

8338. Was not it your experience in America that, although the information of people was very wide spread, it was excessively superficial?—Yes.

8339. And that they have very much an objection to working hard at anything?—What they call labour-saving machines are prized by them excessively.

8340. And did you notice that their elementary books were not made for thorough study?—I should say that their elementary books generally were very deficient in scientific method, and were mostly compilations from standard works, put together without much skill.

8341. Has your attention been drawn to the very important subject of the manner by which the passage can be effected from the elementary schools to the schools of a more advanced character in England,

because, at present, there is no recognized method by which children who have been instructed in elementary schools can get higher instruction in secondary schools?—I thought that that was the point in which we had more to learn from the American system than any other. I ventured to call public attention to it in my Report, and suggested whether the system of gradation was not one that we might adopt with very great advantage, at least, in large populations.

8342. That would not require, I presume, the establishment of new schools, inasmuch as, all over the country, there are an enormous number of endowed schools?—They might be all put under one system and graduated.

8343. And so with regard to teaching science, supposing elementary scientific instruction were to be given in elementary schools, it should, by right, be connected with the higher scientific instruction in the secondary schools?—I think so. In the city of Manchester, for instance, there are all the elements but one of a system such as I have described. There is a large system of primary schools, or, as we call them now, elementary schools, all over the city. There is the grammar school, which would correspond with the American Latin high school; and there are also some commercial schools, which would correspond with what the Americans call their English high school, and you have, at the top, Owens College as a university, so that you only want at certain intervals over Manchester, some secondary schools, and the system would then be complete, if its different parts could only be brought into proper subordination.

8344. But when, under the Act, your elementary schools are established in Manchester, there is no method whatever, is there, of enabling children who can afford to stay longer at school, or children of ability, that are taught in elementary schools, to pass into schools of a higher character?—Nothing at present, and I am not aware of anything of that sort at present anywhere in England. I think, however, that I have heard of some such arrangement in the schools at Faversham.

8345. I suppose that, originally, the grammar school at Manchester was intended for the very poorest class of the population?—I do not know that it was for quite the poorest class of the population. Hugh Oldham founded it for simple instruction in grammar, which he considered to be the foundation of all the sciences, as he said, from which they all “surge and spring,” and the grammar to be taught was to be the grammar in use at the school at Banbury, which, I suppose, was then a celebrated grammar school.

8346. Most grammar schools are open to the children of free men at any rate?—This was meant to be absolutely a free school by the will of the founder. The trustees have lately, by a scheme in chancery, modified that feature in the school, and considerable difference of opinion has been excited in Manchester as to whether they have done right, or not, in that modification.

8347. The elementary education of the country depends, does it not, a great deal upon the character of the masters who are supplied to the elementary schools?—I think the common maxim is applicable here, that as the teacher is, so is the school.

8348. Do you think that there is sufficient provision for training teachers in the country at present?—Certainly not. When the elementary education bill was under discussion in the House of Lords, I called the attention of the House to that very fact; that it is contemplated that we ought to have 4,000,000 children in school, and even supposing that you allow so high an average as 100 children to a school, that would require 40,000 schools and 40,000 teachers at least. Now we have training colleges which, if they were filled to their maximum capacity, are able to turn out 1,600 teachers per annum. Mr. Forster told me that there is an annual waste of 900, so that there is a gain every year of only 700, and I put the case to the House in this way—there are only 15,000 schools at present supplied, and 25,000



remaining to be supplied; how long will it take to supply the 25,000 with trained teachers out of that gain of 700 per annum? It seemed to me that it would be something like 35 years before the Education Act could come into anything like efficient operation, unless our power of producing teachers is very much multiplied.

8349. Have you made any suggestion as to a practical method of increasing the number of teachers?—No, I have not.

8350. Have you any opinion yourself as to the means we should take? do you think that the action of the Government should be recommended in establishing Colleges?—The action of the Government failed in Kneller Hall, I do not know for what reason, but the Government did try to set up a training college of its own, and it broke down, although it was under the admirable superintendence of Bishop Temple; whether it was that the teachers did not like their vocation as masters of workhouse schools, I do not know, but, for some reason or other, it broke down.

8351. I suppose if such colleges were established, or in any such as may exist, I may assume that you would like to see some provision made to instruct the teachers in the elements of science, so that they might be able to give the taught some conception of what science is?—The period during which those teachers are under training is very short; it is only two years; and I think it would require a good deal of discretion. The danger would be again the American danger of dissipating the mental power over too wide a field. I think the general impression is that the present Government programme is wide enough for the capacities of the teachers that we at present have to deal with, within the limited time at our command.

8352. Suppose that they could be made to understand that the kind of instruction to be given to children was such as I have sketched out, that is not an instruction that requires any very profound study, it only requires thoroughness of knowledge, as far as that goes, and that might be given, I presume?—Quite so; but the tendency of Government interference in elementary instruction—I refer to the Revised Code—has been to narrow, rather than to extend, the range of subjects.

8353. Has not the action of the Revised Code, in your opinion, been injurious to the progress of sound education?—I would not say injurious to the progress of sound education; it has narrowed the field within which the faculties of the children had their play before. I do not say that the instruction given is not sound. I think that, on the whole, it is probably sounder than it used to be.

8354. Perhaps, the lopping process, which has been resorted to to get rid of a great deal of excrescences, has smitten the trunk of the tree somewhat?—Perhaps, it was carried rather too far.

8355. (*Sir James P. Kay-Shuttleworth.*) Especially taking into account the course of education in training colleges, you would scarcely recommend that it should be cut down to the rudimentary condition in which it now is?—I should not. The Revised Code has diminished the number of hours during which the pupil teachers are under instruction from  $7\frac{1}{2}$  to 5, that is reducing it one third. If that instruction were equally well given under both regulations, you may say that those pupil teachers when they come into the training colleges come with one third less knowledge than they came with before the Revised Code was in existence, and so far, of course, they would

The witness withdrew.

Sir FRANCIS R. SANDFORD examined.

8360. (*Mr. Samuelson.*) I think the Commission are tolerably well agreed that something is required to test the efficiency of the instruction in the classes in

be one third less prepared for such a course as you suggest.

8356. Were not the motives of teachers to give that instruction somewhat impaired by the new arrangement, awarding no payment for the result of that instruction?—No doubt.

8357. Then the pupil teachers, coming into the colleges with less preparation, both on account of the diminished time and the diminished zeal of their masters, had likewise a syllabus of study which was narrower in extent and inferior in aim to that which existed before?—Yes. With regard to this question, generally, nothing struck me more in the contrast that I noticed between the American schools and our own than the great contrast between the raw material of the teachers. It seems to me that in the American teachers, particularly the American women, you have the very best raw material for teachers that I ever met with, in their liveliness, energy, force, enthusiasm, and laudable ambition to excel; whereas, in England, we know that we have to deal with a somewhat lethargic national temperament, which seems to me, on some occasions, to require more stimulus than it gets to induce it to desire to excel. It is very seldom that you meet in an English school with a thoroughly vivacious, energetic teacher who seems heartily in love with his work, and doing it with force and success. It is quite a rare thing to meet with. In America, on the other hand, it is the rule and not the exception; here it is the exception and not the rule.

8358. (*Chairman.*) Do you think that much more can be attempted in elementary schools in large towns than in rural districts?—Yes, I think you may do more in town schools. The education of the streets, although mischievous on the one side, is very effective on the other; children passing through the streets and looking into the shop windows get acquainted with an infinite number of objects which rural children have no conception of; but, on the other hand, it has its dissipating effects on the mind also, for, when I was employed on the Agricultural Commission, I took a good deal of evidence from militia officers, the adjutants, and others who deal with recruits; and the other day, in fact, I was asking the colonel of a regiment stationed at Manchester whether he thought the recruits from agricultural districts the best, or recruits from the manufacturing districts and towns; and I think, without exception, every officer that I have asked has always given his preference in favour of the agricultural districts, not only on account of the superior physique of the men, but also, while admitting that they take a longer time to drill, because, they say, when they get hold of a thing they hold it much more firmly, and give much less trouble afterwards, than the sharper man from a town, who exercises his wits rather too freely and thinks, perhaps, that he knows as much as his officers.

8359. In answer to some questions of Sir James Shuttleworth, you spoke of instruction in physical geography in elementary schools; in the great majority of schools, and especially in rural districts, that you were acquainted with, was there any attempt at teaching physical geography?—Hardly beyond the points which I have referred to; I do not think it was taught upon any system, but ordinary phenomena were explained sufficiently well within the intelligence of children. In a great many schools geography is not taught at all. In fact, I reported to the Duke of Newcastle's Commission that, amongst something like 300 schools that I personally visited, I only remembered one in which I saw such a thing as a globe, and I suppose you could not teach physical geography very well without a globe.

Right Rev. J.  
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12 May 1871.

Sir F. R.  
Sandford.



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12 May 1871.

of the present Inspectors of the Committee of Council on Education could be made available for the kind of inspection which seems desirable?—Our districts are much reduced in size compared with what they used to be, and Inspectors will be found in many of the large towns now. I do not know that it would be impossible to give them some time to look after those classes a little and inspect them, but a constant supervision of them I do not think they could undertake.

8361. The first thing which it would probably be desirable that they should look after would be to see that the classes had the proper teaching appliances. Do you think that that could be entrusted to your Inspectors?—If some competent authority pointed out what were the proper appliances to be provided, I have no doubt that they could see that they were provided; but there are few of them who would be competent to advise science classes upon what ought to be done, and what provision ought to be made. I think if some authority were to prescribe it, they could see that it was done, but beyond that I do not know that they could do much.

8362. I do not know whether you are aware that the inspection, such as it is, consists of supervision by three gentlemen of the Science and Art Department, assisted by a number of Engineer Officers. Without depreciating the qualifications of the Engineer Officers, would you consider that your Inspectors would be as well qualified as those gentlemen for the purpose of the inspection of science schools?—I should think so. Supposing a science school to be once started and equipped, they would be able to inspect it; but I should not think they would be as well qualified to assist or advise in its organisation as the Engineer Officers, because few of them have had any special scientific education which would make them competent to advise in such matters.

8363. But their general education and acquaintance with schools, you would suppose would give them some advantage?—Yes, certainly.

8364. In respect to time, you think there would be no difficulty?—That would depend, of course, entirely upon the extent to which those science classes are developed. There are a large number of them now, I know, but if there were not any very minute supervision required, I have no doubt that the Inspectors might look after them to some extent.

8365. Would there be any departmental difficulty?—I think not, so far as we are concerned. At present we are engaged with primary education only; the Science and Art Department and ourselves work entirely separate. As time goes on we shall probably work a little more together, and I do not see why our Inspectors should not be made available for the work of both Departments.

8366. In point of fact, there is a tendency now towards working more in connexion than was formerly the case?—Yes.

8367. On the other hand, I believe that, under your last Code, you expect that some elementary science teaching may be introduced into your elementary schools?—Yes.

8368. Have you considered at all how the examination in those subjects is to be conducted in those schools?—As hitherto, by papers only. At present, the managers of schools, in the notice that the Inspector is going to visit them, are asked to say in what special subjects they wish their scholars to be examined, and if the Inspector receives notice that some subject will be taken up of which he is ignorant, he refers to headquarters; and in our staff of Inspectors and Examiners we get some one to frame papers for him and assist him in revising them.

8369. Then you contemplate nothing beyond an examination by papers, at present, with reference to elementary science education in elementary schools?—Quite so.

8370. You are increasing the number of your Inspectors, are you not?—Yes.

8371. Are you also appointing a large number of Assistant Inspectors?—Yes.

8372. Are you giving a preference at all to gentlemen who have some acquaintance with science for those appointments?—Not specially.

8373. Are you meeting with gentlemen who have some acquaintance with science whom you can appoint to such posts, who are qualified in other respects?—We have not inquired into that point specially. When the recommendations of the candidates for inspectorships are sent, men are chosen who have taken good degrees at the Universities; but, in selecting the Inspectors recently appointed, I think we have looked more, perhaps, to our own work than to any probable extension in the direction of science.

8374. Do you recognise that it would be useful to entertain that consideration in future appointments?—Certainly.

8375. As a matter of fact, amongst your Inspectors and Assistant Inspectors are there even a small proportion of men competent to conduct, in the first place a written examination, and, in the second place, a *vivâ voce* examination, in very elementary science?—Scientific subjects have been brought up so very seldom in elementary schools that the question has not forced itself on our attention. There was what we used to call Mr. Corry's Minute, under which the children might be examined in subjects beyond reading, writing, and arithmetic; but the subjects proposed in the schools were so very seldom of a scientific character that the question has never arisen. We know that Mr. Cowie, for instance, and some of our other Inspectors, men who have taken high degrees at Cambridge, are competent. Mr. Cowie advises in all those points where any necessity for special consultation with an Inspector arises. If an Inspector, for instance, in the country were to say, a scientific subject is proposed in which I cannot examine; will you prepare papers for me? we should request Mr. Cowie to draw up the papers.

8376. In point of fact, you have not yet put into practice what you admit to be theoretically desirable, that you should require from your Inspectors some knowledge of physical science, provided they also possessed the other requisite qualifications?—We have never had a necessity to do so.

8377. Has it been contemplated that the special attention of the elementary schoolmasters shall be directed to any special subjects in elementary science as being desirable to be taught?—The only thing that has been done in that direction is, that in the fourth schedule attached to the New Code certain suggestions are made as to the subjects which may be taken up for the extra grant. Physical geography and animal physiology are pointed out, but it is left to the managers of each school to select what subjects they will offer for examination.

8378. Are those the only two subjects which you have pointed out?—They are specially named.

8379. You have not named physics nor chemistry?—No.

8380. Has the matter received much consideration as to what subjects should be specially proposed and recommended?—The suggestions in the schedule were made upon Mr. Cowie's recommendation, but upon what principle he made his selection I am unable to say.

8381. (*Professor Huxley.*) It was considered quite a temporary arrangement, I believe?—Yes, the idea was thrown out to see how it would work. Just when the New Code was being launched, a deputation, as I think you will remember, waited on Mr. Forster, and urged the necessity of the encouragement of scientific instruction in elementary schools; the fourth schedule was drawn up to show that the Department was not indisposed to meet the wishes of the deputation.

8382. (*Mr. Samuelson.*) May the Commission take it that that subject is about to receive full consideration from the Department?—Yes. At present you are aware that we are busy supplying schools, and until we get a little further and have more children at school, and more schools for them to go to, our



hands will be pretty full; we have not gone into that question yet.

8383. You have many other things to think of and to organize at present, and you have not had time to attend to this?—Quite so.

8384. But you quite recognize it as a subject to which you will have to give attention?—Yes, certainly.

8385. So far as the question of inspection is concerned, you might perhaps, on the other hand, derive some assistance from the Science and Art Department?—Yes, certainly.

8386. You stated, before, that there is no indisposition on the part of either of the two divisions of the Department to co-operate with each other?—Certainly none on our side, and I am pretty certain that there is none on theirs.

8387. (*Sir J. P. Kay-Shuttleworth.*) Have you ever considered whether by, what I should describe as, a graduated inspection the wants of the two Departments might not be, perhaps, better provided for than by separate systems of inspection. I will define the objects to which that graduated inspection should apply itself. First, to the examination whether the schools which are giving instruction in elementary science are held in proper buildings, with proper appliances, such as are adopted in elementary schools for class instruction with the ordinary school apparatus, particularly with the means of giving practical instruction in manipulation, or instruction from specimens in elementary science. Then with respect to schools which are more developed, such as the schools connected with the mechanics' institutions of great towns, whether there are or are not chemical and physical laboratories, herbaria for instruction in botany, and sufficient specimens to illustrate lectures and class instruction in geology, and in the sciences of observation generally; and then, further, whether, in those several institutions, the methods of instruction were sound, and there was a proper class organisation and proper discipline in the several rooms used for instruction. Taking into account those as objects of inspection in elementary scientific schools, would you think it a matter for consideration, whether those objects could not be provided for by a graduated inspection which should be co-ordinate with, or subordinate to, the existing inspection?—All that you are pointing to I think will grow out of the development of the Endowed Schools' Commission. Our attention hitherto, as you know, has been devoted solely to primary education, and from the early age at which children leave school we have never had a very extended system of instruction to think of. But under the influence of the Education Act, and the more regular and enforced attendance of children, the standards of instruction will I hope be gradually raised, and as the endowed schools will, I presume, eventually come under the inspection of the Department, I see no difficulty in having classes of inspectors, such as you point to, selected to look after this more extended instruction in which we shall have to examine. The present class of Inspectors' Assistants, as we call them, or Assistant Inspectors, might attend to the elementary instruction, and the superior Inspectors to the more extended branches that you have alluded to. I do not see any difficulty in that.

8388. If you conceive of there being a class of superior Inspectors to whom the other Inspectors should be subordinate, and all properly subordinated to one department, you can conceive that the objects of a scientific inspection, such as I have described, and even of a scientific examination of classes, might ultimately be provided for?—Yes.

8389. Your system of inspection will necessarily be extended when you come to deal with the night schools?—Yes.

8390. There is a considerable analogy between the schools under the Science and Art Department and night schools, inasmuch as the persons taught belong to the same grade?—Yes.

8391. Can you conceive that it may be desirable to organise a system of inspection in such a way as to cover elementary schools, not being day schools, whether they be elementary science night schools or literary night schools?—I do not think there is much difficulty about it; give us a system of schools to inspect and I think we could very soon organise a system of inspection; but until those schools come up, and until we know what will be done in them, I do not see how we are to proceed.

8392. Do you think there would be any advantage in the concentration of the inspection of schools under one department?—I think there would be a very great advantage.

8393. (*Chairman.*) Are your Assistant Inspectors gentlemen of the same class as the Inspectors?—The Inspectors' Assistants are schoolmasters.

8394. Who have given up their work as schoolmasters?—Yes. They must be below 35. Hitherto 30 was the age, but Mr. Forster has raised it to 35; they are teachers of elementary schools, who are withdrawn from these schools on being appointed Inspectors' Assistants, having to give up all their time to their official duties.

8395. Not usually University men?—No, never University men, I may say.

8396. (*Sir J. P. Kay-Shuttleworth.*) It would not be very difficult to find among that class of men persons who have, by various methods, and by the accident of their vicinity to some considerable college, such as Owens, or who live in the neighbourhood of London, acquired a fair knowledge of elementary science, and who could give important assistance to the Department under the direction and guidance of the principal Inspectors?—No, that would probably be easy.

8397. If it were once found that the Department had an object of that kind to fulfil, such men could be found in that grade of Inspectors as well as in the other?—Probably. A good many teachers come up to the University of London, and take degrees both in arts and science.

8398. (*Mr. Samuelson.*) Having in view the encouragement which you propose to give to extra subjects, some of which will be scientific, do you propose to make any change in the syllabus of your Training Colleges, or has that subject been considered?—That subject will be considered this year; in fact it is being considered, but, as I say, our hands are very full.

8399. In fact, in any system of encouragement to the education of schoolmasters, whether by training colleges or otherwise, you would consider the desirableness of introducing some instruction in science into the curriculum?—Yes.

8400. (*Sir J. Lubbock.*) At what age do you consider that the first standard might fairly be expected to be passed in village schools in the country?—In the new first standard children cannot be examined till they are seven.

8401. Do you not think that there are very many children who might pass in that standard at the age of six?—We have not found it so.

8402. I infer that your opinion is that there would not be any very large number?—I am afraid not.

8403. Then the six standards would be passed between the ages of 7 and 13?—Yes, from 7 to 13.

8404. Surely there are many children in country districts who would be disposed to remain at school rather longer than 13, not, perhaps, the children of agricultural labourers, but the children of small shopkeepers, country builders, mechanics, and so on?—If it is found that they do so, we must have a seventh standard, I presume, and we should have to pay for them.

8405. They are not likely to do so until you have some seventh standard, are they?—There is no pressure upon us, at present, to make a seventh standard, because so very few rise to the fifth and sixth. We have virtually made a seventh standard,

*Sir F. R.  
Sandford.*

12 May 1871.



Sir F. R.  
Sandford.

12 May 1871.

because the sixth standard of the New Code is like a seventh in the old. We have gone one step further.

8406. In the use of the word "science," in your answers to some of the previous questions, I think you have rather applied it as including everything excepting reading, writing, and arithmetic, in fact to the extra subjects generally?—Yes.

8407. You were not using it in the strict sense, but in a practical sense?—Quite so.

8408. Do you not think that most of the existing Inspectors might be competent to examine in what you call extra subjects in the New Code, so far as they are likely to be learnt by the children of the ordinary ages of those attending village schools?—I doubt if many of them could do so in strictly scientific subjects.

8409. I think I understood you to say that you were not selecting your Inspectors with any reference to science?—Not specially.

8410. When you say not specially, do you mean not at all?—We have chosen men who have taken good degrees at Oxford and Cambridge pretty much alternately, to keep the balance between the two Universities, or from the London University; but certainly we have not specially looked at that question in selecting them.

8411. I should have thought, myself, that they would probably have been able to examine in most of the extra subjects?—In most of the extra subjects in the schedule, perhaps, but take Professor Huxley's subject, animal physiology; I should think there are a good many of them who, if they were asked to examine in that subject, would know comparatively little about it.

8412. Do you not think it would be necessary to have a certain number of Inspectors who are qualified to examine in the subjects which are included in the curriculum?—Yes, that will have to be borne in mind; but you must remember that this curriculum has just been launched, and, as to the Inspectors, we had gone so far in selecting them that they were nominated before this schedule was contemplated.

8413. You have nine months, I think, before any examination can take place?—Yes.

8414. I presume that, before that time, you will take into consideration the necessity of having Inspectors who are qualified to examine in the branches of knowledge that may be chosen?—I think we shall be able to make arrangements in any district where those special science subjects are brought up to enable the Inspectors to do so.

8415. At present, is not the allowance for attendance 6s. under the New Code?—Yes.

8416. And 4s. each for reading, writing, and arithmetic?—Yes.

8417. Therefore, that would make 18s., and the largest amount that can be obtained by any child is 15s.?—Yes.

8418. Therefore, does not it appear that the encouragement to the study of the special subjects is very illusory, and that they are not likely to be adopted to any extent?—Last year the Government said that they would increase the grants 50 per cent. If we had started with the payments in the Code on the scale which may eventually have to be adopted, that promise would not have been fulfilled; but if we find that the schools get their 15s. too easily by passing a certain number of children in the lower standards of examination, we may increase the grants for special subjects, and reduce them for the ordinary standards.

8419. Surely you would have fulfilled, would you not, the pledge given to the country, if you had left the grants for attendance, reading, writing, and arithmetic the same as before, but enabled the schools to obtain a larger grant by giving some encouragement to extra subjects?—There are very few children in the schools that are competent to take them up yet. Last year there were only some 80,000 children presented in the higher standards, and it would have been somewhat illusory to have put large grants upon those higher standards in which so very few children are examined.

8420. In one of the subjects, geography, I see that, in standard 4, the knowledge of geography which is required is "a knowledge of the chief divisions of the world and of the meaning of a map;" as no child can pass standard 1 till he is seven years old, the children who would be passing through standard 4 would naturally be 11?—Yes.

8421. Therefore, at the age of 11, all that would be required, in order to pass through the standard of geography, would be a knowledge of the chief divisions of the world and the meaning of a map?—The fourth standard is passed at the age of 10.

8422. At the age of 10, do you seriously think that there would be any difficulty in giving children such a very elementary knowledge of geography as is implied in that standard?—The standard in this fourth schedule was drawn up with reference to what is done in the schools, not to what we should like to be done in the schools; and if we had proposed, at this date, standards of examination which we can only hope to see reached hereafter, we should have been told at once, "This is no use; and you ought to know that it is no use to ask our children to be examined in standards which they are not qualified to pass."

8423. They might not be qualified to go further, but my question is, whether there would be any difficulty in bringing a fair proportion of children at the age of 10 up to such a very elementary knowledge of geography as is implied in that condition?—No difficulty, I think, only that this syllabus is drawn up to meet the actual condition of the schools, and not what we are aiming at. If we offer money upon terms which cannot be reached, the offer is illusory, as I said.

8424. But I understand you to say that there would be no difficulty in bringing children of the age of 10 up to that?—There would be none, but they are not now brought up to it.

8425. If they are to learn to read and write, I presume they must read and write something?—Yes.

8426. At the age of 10, what is required in history is, that the master should "select some chief event of importance in the History of England since the Conquest, and let the children in standard 4 know something about it in detail." If a child was to learn to read out of an English History book, do you consider there would be any difficulty in getting him to know something about some event of importance in English History at the age of 10 years?—Something; but, of course, as to the something we must trust to the Inspector.

8427. I presume he would not be unreasonable in what he would require, nor unduly lax in what he would expect; but assuming that the Inspector is a man of judgment, who knows what can be expected of a child, that does not occur to me to be a very severe test to apply to a child of 10 years' old?—I examined for the University of Oxford when they started the Middle-class Examinations, and we could not have got that from lads of 13, 14, and 15, who came up in the junior standard from the middle-class schools.

8428. But then you required other things in addition?—Yes.

8429. But I am assuming that for the three previous years, that is, from the age of 7 to the age of 10, a child's whole school-time, excepting that devoted to arithmetic, and to mere reading and writing, has been devoted to a knowledge of the chief divisions of the world and the meaning of a map, if he takes up geography, or to attain some knowledge in detail about some event in English History; in either case he would have been able to obtain the whole extra grant, even if no addition had been made to the grants for reading, writing, and arithmetic?—If we had been framing a code to come into operation three years hence, we might have made the standards considerably higher; but, at three months' notice, our schools this year are to be examined in these standards, and, therefore, we are obliged to propose terms which can be met. I think it comes back to what I said before, that if we had fixed an ideal standard, it would not have been



reached, no more money would have been earned, and the promise of an increased grant would have been illusory.

8430. Take physical geography, another of the extra subjects: I would ask you whether you do not think that geography and physical geography ought to be taken together, and whether it is not undesirable to separate them very distinctly from one another?—Yes.

8431. Coming to physical geography under standard 4, which a child passes at the age of 10, the standard is "figure of the earth, distribution of the land and sea, form of continent:" no doubt that is somewhat vague, but assuming that that would be interpreted by the Inspectors with reference to the acquirements to be expected of a child, that does not seem to me to be any very serious tax upon their acquirements?—No, I do not think it is.

8432. I think, as I understand this fourth schedule, it is open to the Committee of the school to choose any reasonable subject to which the attention of that school has been directed during the previous time?—Yes.

8433. Therefore, supposing the case of a school with a certain number of children of the age of 10 who are qualified to pass in standard 4, and assuming that they had not taken up any one of the extra subjects mentioned in the New Code, but had devoted themselves to some other reasonable subject, that would be accepted?—Yes.

8434. I presume that the same kind of standard would be applied to those subjects as is indicated in the fourth schedule, and that these are given as indications of what you expect them to have acquired?—Yes.

8435. Considering the very elementary knowledge which is required under standard 4 in those illustrations which are given, does it not seem that, really, if the children had been taught anything whatever in the school, they would be able to obtain this extra grant for at least two out of the three subjects, if they have learned anything; and if they have learnt absolutely nothing in the course of three years, what is the use of a school which is conducted in such a manner, why should it have the extra grant, or indeed any grant?—We shall see; we do not know yet in any single school what has been earned under this standard.

8436. You do not give more than 15s. a head, and they can get 18s. without taking those extra subjects; is it likely, then, that any large number of children will be tendered for examination in extra subjects? and if they are not so tendered, will you have any opportunity of ascertaining whether they are learning anything beyond the mere mechanical act of reading, writing, and arithmetic?—I think so; that is a point that we are aiming at. If we find they can do so, and do so too easily, this Code is not stereotyped, it varies from year to year; if 12s. is too much to pay under the standards as compared with 6s. under the special schedule, we might even reverse the order of things, and give 6s. for the standards and 12s. for the special subjects, but until we have a little experience we cannot say what will be done.

8437. But they would get 18s. by merely reading, writing, and arithmetic, and, therefore, if they passed in two out of the three of those subjects, either reading and writing, or reading, and arithmetic, or writing and arithmetic, they would get all that they can get?—Yes.

8438. What, therefore, is the inducement to a country schoolmaster to send any children in for examination in those extra subjects, if he can get everything that he can get at all by simply reading, writing, and arithmetic?—As I said, we have made this offer, and we must make it easy for them to get 15s. If we find that they do so too easily, we can then alter the terms.

8439. You have made the knowledge which is required, under the fourth standard, in all those subjects so extremely simple that a child who has been devoting his whole time for three years to any one or two of them, unless he is absolutely an idiot, can pass it;

therefore, as far as ease is concerned, you have yourself admitted that it is perfectly easy for any well-managed school to pass its scholars in those extra subjects?—Yes.

8440. But what I wish to impress upon you is, that it seems to me that there is no inducement to the masters of small schools to send in for examination any children at all under those extra subjects, and that, therefore, at the end of the year, you will really know no more upon that subject than you do at present; because, if a schoolmaster can obtain all that it is possible for him to get without sending in any children to be examined in the extra subjects, how will you ascertain whether they have any information with regard to those extra subjects?—Those subjects must be in the time table and must have been taught in the school, and if the Inspector goes to a school and finds that pupils are not presented for examination in special subjects, probably his standard in the ordinary subjects will be raised, so as to make it not quite so easy for them to earn the 15s. in those subjects. It can be done by screwing up the standard of examination.

8441. (*Sir J. P. Kay-Shuttleworth*.) The efficiency of a school depends on the competency of the head master and on the competency and sufficiency of the staff of assistants; and in proportion to the number and skill of the staff, the cost of conducting the school increases: is that your experience?—Yes.

8442. If, therefore, very considerable success were attained in the instruction in the elementary subjects, and, likewise, the upper classes were generally presented for examination in, at least, two of the higher subjects, would not such a school be considerably more expensive than a school which did not attain that degree of success?—Yes.

8443. Is it not a fact, that, while a considerable number of the less successful schools cost from 21s. to 25s. per scholar in average attendance, some successful schools cost from 30s. to 35s. per scholar?—I believe some of them do.

8444. Not wishing to suggest anything which might cause embarrassment to the Department, would it not be obviously equitable that a school which necessarily costs 34s. per scholar should be allowed at least to earn half the grant, which is at present limited to only 15s.?—That is a question rather for the Chancellor of the Exchequer. We are quite willing to spend what is necessary.

8445. But does not that question necessarily enter into the considerations which Sir John Lubbock has brought before you, as to the means of obtaining the degree of excellence which he looks forward to in schools by improving their efficiency by means of their staff, and, therefore, by a staff which requires a higher degree of payment?—Yes.

8446. (*Mr. Samuelson*.) Do the standards apply equally to half time schools as to whole time schools?—Yes.

8447. In considering those standards, are you obliged to have regard to what can be attained in any of those half time schools?—Not much.

8448. Why not?—Because we find that a good half time school very often does as well as a whole time school in reading, writing, and arithmetic.

8449. Does that apply to all the standards?—I cannot say.

8450. (*Sir J. Lubbock*.) I understand the tendency of Sir James Shuttleworth's questions to you, just now, to be, that the schools which take up the extra subjects are likely to be more expensive, and, therefore, would have a fair claim to a larger grant; but, with regard to that point, I should like to call your attention to the amount of knowledge which is required of children who are passing the sixth standard, which is the highest standard that we have at present, and to ask you whether you do not consider that schoolmasters, generally, are qualified to give such information, at least in one or two of the branches that are required from children passing under the sixth

*Sir F. R. Sandford.*

12 May 1871.



Sir F. R.  
Sandford.

12 May 1871.

standard?—If you mean that any master who can bring his children, generally, up to standard 6 would be able to prepare his children in one of the extra subjects, I think he certainly would.

8451. Since the New Code was issued I think that there has been a modification of it with reference to the subject of music, that any school which does not teach a certain amount of music is to receive 1s. per head less?—Yes.

8452. May I ask you what are the reasons for giving music so marked a predominance over all the other subjects in the fourth schedule?—The pressure upon the Department to make music compulsory.

8453. Would not it be perfectly easy to make a similar arrangement with regard to one or other of the extra subjects, and to say that no school which did not pass its pupils in one, at least, of the extra subjects should receive the whole grant, and fine them again another shilling in that way?—It might be possible.

8454. It certainly would not be unjust to schools, for, if they have been teaching anything, there must be some one subject in which the children, at the age of 10, could pass in the very elementary knowledge of which is required under the fourth schedule?—Yes.

8455. That, no doubt, would very much influence the masters, and they would probably send their children in for examination in one or other of those subjects, would they not?—Yes.

8456. Then you would really ascertain what the present condition of their schools is with reference to those extra subjects?—Yes; but I have never thought of that way of enforcing it.

8457. Then your opinion, as it stands, is that it would be favourable to such a course?—I do not say that it would be favourable. It has never occurred to me to treat those subjects in that way.

8458. Should you, yourself, see any reason in the nature of things why so great a preference should be given to music?—No.

8459. (*Professor Smith.*) With reference to the

payments to the scholars for passing, the maximum amount that can be received by any one scholar is 24s., is it not?—The maximum that can be earned by an individual scholar is 12s. by examination in the standard, and 6s. by examination in extra subjects; that makes 18s. Then he contributes, of course, to the average grant of 6s.; but that 6s. is not given on account of any individual scholar, but it is given upon the average attendance in the school.

8460-2. But although not more than 15s. per scholar can be paid on an average, yet, if some scholars may gain more than 15s., they might raise the whole amount received by the school to the maximum, by making up for a certain proportion of failures?—Yes.

8463. Therefore, there is an inducement to the managers of a school to endeavour to pass as many children as possible in the extra subjects, in order to make up for the loss of other children in failures?—Yes, there is that inducement, certainly.

8464. (*Sir John Lubbock.*) What are the subjects which can be taught in elementary schools under Mr. Corry's Minute?—Geography, grammar, history, composition, arithmetic (mental and higher), music, domestic economy, physiology, recitation, and letter writing were paid for under that Minute last year.\*

\* Table [subsequently supplied by Sir Francis Sandford] showing the number of schools to which grants were made in the year ending 31st August 1870, under the Minute (Mr. Corry's) of 20th February 1867, as embodied in article 54 of the Code of 1870, for proficiency in each of the following "specific subjects of secular instruction:"—

Geography	-	-	-	3,445
Grammar	-	-	-	825
History	-	-	-	304
Composition	-	-	-	127
Music	-	-	-	49
Higher arithmetic	-	-	-	39
Algebra	-	-	-	1
Domestic economy	-	-	-	13
Physiology	-	-	-	2
Recitation	-	-	-	1

The witness withdrew.

Adjourned to Tuesday next, at half-past 11 o'clock.

No. 6, Old Palace Yard, Westminster, Tuesday, 16th May 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

Sir JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

Sir JOHN LUBBOCK, Bart., M.P., F.R.S.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

The Rev. Canon NORRIS examined.

8465. (*Chairman.*) I believe you were for many years an Inspector of elementary schools under the Education Department of the Privy Council?—For 15 years, from 1849 to 1864.

8466. During that period, did any schools come under your observation in which elementary science was taught to any extent?—Yes. At Stoke-upon-Trent, we started a chemistry school about 15 years ago, and it lived and flourished for about 18 months, and then collapsed, owing to accidental circumstances. The master, who was recommended from Jermyn Street, misbehaved, and the school was discredited.

8467. Was anything done in the elementary day schools in the way of teaching science?—In the elementary day schools some little was done. The late Dean of Hereford, and Mr. Fearon of Loughborough, and Mr. Rigg, the Principal of the Chester Training College, set the fashion, some 20 years ago, of teaching common things, and the philosophy of common things, to the teachers of elementary schools, and the last-named gentleman, Mr. Rigg, turned out some very accomplished teachers; and many of the schools under my

own observation engrafted some little teaching in natural philosophy of a very elementary kind into their other work, and with good results, by which I mean that they interested their boys.

8468. What extent of country was under your supervision?—The three counties of Cheshire, Staffordshire, and Shropshire; and, latterly, Kent.

8469. And were the schools in which this scientific instruction, of which you have been speaking, was given, in a manufacturing or in a rural district?—In both. In some rural schools lessons were given in organic chemistry with a bearing on agriculture. In the mining districts some instruction was given of a very elementary kind in mining science; maps of the workings of coal mines were hung up, and a few lessons were given, and, nearer Birmingham, we had machine drawing taught, with plane geometry.

8470. Do you know whether this education still goes on?—I believe not. I am afraid it has all collapsed under the Revised Code.

8471. Do you attribute this collapse to the action of the Revised Code?—In a great measure. I do not

Rev. Canon  
Norris.

16 May 1871.



mean to prejudge the question, whether it was wise or unwise that instruction should continue to be given or not, but so it has been.

8472. Do you think that a certain amount of elementary teaching in science can be given to advantage in elementary schools?—I should deprecate any systematic instruction.

8473. But you draw a distinction between systematic instruction and any other kind of instruction?—I should be very glad, indeed, if every teacher of an elementary school had been so educated, and were able, in the reading lesson or on a Saturday walk, or in odds and ends of time, to interest his boys in what we used to call “natural philosophy.” Beyond that I should deprecate any introduction of it into an elementary school. Boys leave so early, and they have so much to do in the time, that the business of an elementary school being education rather than instruction, I should deprecate imposing on the teacher any systematic duty of instruction in applied science.

8474. You would not like it introduced as part of the regular school work?—No. At the same time, desiring very much that the teacher should have an interest in it, and should, *by the way*, interest his boys in it, so as to make sure that any boys of promise should be known to him, and put into the way of going forward through some career, through some intermediate technical school, and so up to the Royal College of Chemistry, or the School of Mines in Jermyn Street, or some such school.

8475. Your view would be, that the action of the Revised Code in putting a stop to any regular instruction of that kind was not very greatly to be regretted?—No, I was in favour of it. I considered the matter carefully at the time. The Code knocked on the head a good deal of grammar and geography and history, but on the whole I doubt whether it was much to be regretted. It was still more important to make the children really good readers, writers, and accountants, and we were neglecting these rudiments in the lower classes; and, on the whole, we had gone too far, I think, in the direction of general culture without making sure of the groundwork. Now that we have remedied what was then defective, I should be very glad to see a little more done in the old direction; but, at that time, the pendulum had swung too far in the one direction, and it was needful, I think, to bring it back to a just mean.

8476. You think it desirable that the teachers themselves, generally, should have a certain acquaintance with the rudiments of science?—Most desirable.

8477. But is there any encouragement to them to acquire such a knowledge at present?—Not enough.

8478. How would you suggest that they should be encouraged to acquaint themselves with science?—I think that if the training colleges could be inspected by a scientific Inspector, such as Captain Donnelly, for instance, under the auspices of the Science and Art Department, and if grants could be made to them to enable us to have laboratories and workshops attached to the training colleges, as at Chester in the old days, it would be a very good thing.

8479. Your view would be that teachers so trained would be able, incidentally, to take advantage of opportunities of directing the attention of some of their pupils to matters of that kind, without making them a regular subject of instruction?—Exactly.

8480. You have also had opportunities, have you not, of becoming acquainted with evening schools and mechanics' institutes?—Mechanics' institutes merely by the way. I saw what was going on under Sir James Kay-Shuttleworth in Lancashire; and, in concert with Lord Lyttelton, I worked a little amongst the evening classes about Dudley in connexion with mechanics' institutes, but my experience has lain rather with evening schools in connexion with elementary schools, than with evening schools in connexion with mechanics' institutes.

8481. What were the subjects taught in the evening schools with which you have been acquainted?—For

the most part merely making up for previous neglect in the elementary school,—hardly anything but that.

8482. You mean in the primary elements of education?—Yes; in some we had classes in book-keeping and classes in drawing, which were attended, perhaps, by a small proportion of the pupils, but the large majority were simply making up for past neglect.

8483. Were not some of the evening schools of a more advanced description than those of which you have now been speaking, and where more was attempted?—Yes. In South Staffordshire—what we call the Black Country—under our organizing master, Mr. Jones, we had some very successful classes in machine drawing, I remember, and in many of the evening schools drawing was taught; but I cannot now remember more than five or six evening schools where there was any demand for such instruction.

8484. What sort of age were the boys who attended those evening schools?—They ranged from 12 to 22 or 23. They were not allowed to attend under 12.

8485. Do you think that more might be done in the evening schools, in the way of giving scientific instruction, than in the day schools?—Yes, especially in the mining districts, where the boys come up in draughts, a good deal might be done.

8486. Have you considered at all what branches of science could best be taught in those evening schools?—I have learned from wiser men what would be wanted. I remember Sir Henry De la Beche telling me that something ought to be taught about inorganic chemistry to young miners, and something about metallurgy, of which I am profoundly ignorant myself, and, therefore, I only half understood him. In the cotton districts I am told that something of machinery might be taught, I suppose to calculate the work done by a given power, and to make a man a more intelligent minder of *mules*, or whatever his special machinery may be; but I really know so little about those things myself that I am not very well able to understand how it is to be applied.

8487. Were those evening schools chiefly taught by teachers who were also employed in the day in other schools?—No; in those days the certificated masters in charge of elementary schools were forbidden by the Council Office to engage in evening work; that was all altered in 1861–62, but then this kind of instruction had collapsed, as I said before.

8488. Were the teachers of these evening schools, at the time you were acquainted with them, trained men?—Some were; some have been trained under the auspices of the Science and Art Department, and some in Jermyn Street, and some were self-made men, and those did the best for the most part.

8489. Were they men who had other occupations, for the most part, or did they make their livelihood solely by teaching those evening schools?—Not solely; they could not have done so. I remember that in South Staffordshire we had one or two mine agents who were engaged in this kind of work in the evening, and the master in the Potteries who taught chemistry also analysed for the manufacturers. There was a man at Crewe, I think, employed in the works, if I remember right, who taught in the evening.

8490. Do I understand you to say that the evening schools of that description have collapsed since the promulgation of the Revised Code?—No, I did not say so; what I said to your Grace was, that the scientific instruction in elementary schools, as part of the work of elementary schools, had collapsed. I resigned my inspectorship seven years ago, and, therefore, I am not a good authority, but I believe that some of those evening schools are still going on and flourishing.

8491. In what state did you leave them at the time that you resigned your inspectorship, as compared with their condition when you first undertook the duties? Had the character of the teaching in the evening schools improved during that period?—They were less ambitious; they were doing their work better, but with a less ambitious programme than they first started with.

Rev. Canon  
Norris.

16 May 1871.



Rev. Canon  
Nuttall.

16 May 1871.

8492. (Sir James P. Kay-Shuttleworth.) Did you inspect the schools of Mr. Armitstead of Sandbach?—Yes.

8493. Was there any attempt at instruction in elementary science in Mr. Armitstead's school?—In the girls' school there was, but not in the boys' school.

8494. What was the subject that was taught there?—Cooking was taught very thoroughly; they had a gas cooking apparatus, and I used to question the girls, at the Vicar's request, and I found that they understood why fires smoked, and how fuel might be economised to some slight extent. Lessons had been given them on those subjects, and something about the opening of windows, and the need of fresh air for health.

8495. Was instruction in domestic economy, in the same spirit and by the same means, given in any other school in the district than Mr. Armitstead's?—Yes, at Lawton school I remember there was, and a little in Sir Philip Egerton's school, at Oulton in Cheshire.

8496. Was there any example like that of Professor Henslow in Suffolk, where young children were taught habits of observation and instructed in the elements of botany?—Very little indeed. I remember a *hortus siccus*, or something of that kind, and a collection of dried plants at Acton (thanks to Lady Rich, who was then living there).

8497. But that was the only example which you remember?—I do not now remember any, unless there were at Whittington. They had a fossil collection, or something of that kind, at Whittington and at Ipstones, and I think Lord Harrowby was anxious to have something of that kind at Milwich. Mr. Sneyd and Lord Harrowby and a third gentleman, whose name I forget, tried to introduce a little instruction bearing on agriculture in the day schools in Staffordshire, but it came to very little; but there was something in Professor Henslow's direction done there in the way of collecting plants and grasses and cereals.

8498. Are you aware whether they depended upon the acquirements of the master for that instruction, or did some gentleman, or the clergyman himself, promote the instruction by personal tuition?—At Acton it was done by the master, under the inspiration of the manager, Lady Rich. At Ipstones the master did it entirely of his own impulse; and at Whittington it was a hobby of the clergyman.

8499. Supposing that masters could be found in the rural districts to give such instruction, and likewise were instructed in the mode of conveying it to very young children, so as not to press upon them any knowledge beyond their faculties, would you think that instruction in the sciences of observation, for example, in botany, would be a desirable subject of study in a rural district?—I should answer your question as I answered his Grace's question just now. I should be very glad, indeed, that this should be given by the way, but not systematically. I should deprecate it appearing in the time table. That will convey to you my meaning at once.

8500. You would prefer that it should come in illustration of the reading lessons, or, incidentally, as an object lesson, by way of familiarising the children's minds with such subjects, and cultivating in them the habit of observation of natural objects?—Yes, quite so.

8501. In what you call the "Black Country," that is the mining country, were there any schools in which any information was given concerning the gases which are fatal in mines, as, for example, that which is called the choke damp or the fire-damp?—No; to my great regret in none of the elementary schools. I tried to persuade some master to give occasional lectures to his scholars, and to invite the parents who were occupied in the collieries to come, and Mr. Jones, the organizing master, whom I mentioned just now, did give some lectures on the Davy lamp, and so forth, but they were thinly attended, and it fell through; at the same time, there were accidents in every week's local paper, and explosions, simply due to ignorance.

8502. Turning from the day schools to the evening schools of the Black Country, are you aware whether

it was common to give instruction on the Davy lamp and on the phenomena of explosions in mines, and the means of preventing them?—No; they were classes for reading, writing, and arithmetic, for the most part, and they gravitated into the elements almost universally.

8503. Going beyond the evening schools to the lectures which are from time to time given in these districts to large audiences of older people, is any subject of that kind common to those lectures?—I should think not. Mr. Jones tried, as I said just now (and he was very competent to give success to the experiment), but it did not take; the people did not attend and it fell through.

8504. Do you attribute this want of attraction to the ignorance of the people?—Yes.

8505. If, therefore, the first elements of that ignorance were removed, you would expect that the attraction of such lectures and of such instruction would be greater?—Yes, if we could lift the mining district over a generation, and get a more educated set of parents, I think they would be more interested in it, and, also, if the processes of getting coal could be improved. Of course I speak with an imperfect knowledge of these subjects, but I have been down in coal mines, and I have said to my more intelligent companions, "Is not this a very barbarous way of getting the coal," and they have said, "Yes, very." It requires very little knowledge, indeed, of applied science to work in a colliery, and until a little more is required I doubt whether the instruction will be given or cared for. I was very much struck with the contrast in Belgium; I have been down in collieries there. They descended into their pits by "man engines,"—by alternating shafts; the ventilation of the pit is far more scientific than it used to be 15 or 20 years ago in Staffordshire, and the methods of exploiting the coal were very superior. It struck me, in those Belgian mines to which I went in the valley of the Meuse, that there was far more application of science than in any pits that I had seen in Staffordshire.

8506. As to the degree of interest which a child or youth, from the elementary school age up to manhood, might take in instruction in such subjects as the nature of the firedamp, and the means of protection afforded by the Davy lamp and by ventilation, would you be of opinion that it would be desirable that the teachers of elementary schools, going into those districts, should have such an amount of scientific knowledge as would enable them to give, either by way of illustration or in the evening classes, more thorough instruction in those subjects?—Distinctly I should.

8507. On that account you would conceive it desirable that instruction in science should form a part of the syllabus of the training colleges?—I should desire that there should be opportunities in all the training colleges for instruction in science. Whether it would be desirable to make it a part of the syllabus for all I do not know. There may be men that would not profit at all by that kind of instruction, but there would be sure to be some, and there should be an opportunity for all.

8508. At least, you would be prepared to agree that it might be desirable to have such scientific instruction as an alternative subject for examination?—Yes, that would do very well.

8509. You said something of a class of chemistry in the pottery district, which was taught by one of the analysts of the manufacturers there?—It was taught by one who had been under Hofmann in Jermyn Street, and whom we specially invited down to Stoke, and who, when there, helped to eke out his income by analysing for the manufacturers.

8510. He came down as a teacher, did he not?—Yes, as a professional teacher.

8511. But not finding sufficient remuneration from his class in chemistry, eked out his income by analysing for the manufacturers?—Yes.

8512. Was the instruction in that class of chemistry general theoretic instruction, or was it technical, by which I mean, had it special reference to the making of glass, pottery, and china?—It was not under my in-



spection, and I was never present at that evening school, but I knew the man, and had some conversation with him, and I knew the Committee who were locally interested in it, and, as far as I remember rightly, he had to begin at the very A, B, C of chemistry, and before he had got on to any of the applications the school was closed.

8513. Then he was engaged during the time that he stayed in teaching elementary chemistry?—Yes, elementary inorganic chemistry, which is found to be the most popular, as you may know, of all the subjects taught by the science teachers in the provincial centres. In the May examinations that are now going on, inorganic chemistry is found to be beyond question the most popular subject. Out of about 10,000 under instruction, one third are found to take it up for examination, or were so four years ago, when I was asking Captain Donnelly about it.

8514. I believe you are acquainted with the character of Dean Dawes' school at King's Somborne, and with the Bluecoat School which he established in Hereford?—Yes.

8515. Has there been any example of a school conducted like that of Dean Dawes, in which the instruction in the class of subjects for which Dean Dawes' schools were celebrated, has been successful in your district?—The school at Acton was modelled after King's Somborne, and was a very successful imitation.

8516. Did that owe its success to the teacher, or to some clergyman or gentleman who taught in the school?—To Lady Rich, as I said just now, who was living there, and threw herself heart and soul into it, with a master who was competent to do what she wished.

8517. She gave the master the impulse and he carried out her plans?—Yes.

8518. Are you acquainted with Mr. Best's school in the diocese of Salisbury?—I have visited it, but only once.

8519. Were there any schools like Mr. Best's in your district?—Yes, there were several that resembled it, and some that were still better, I think.

8520. Were what are commonly called the higher subjects, that is, beyond reading, writing, and arithmetic, and the elements of ordinary geography, taught in those better schools of that district?—Yes; a Euclid class was very common and very popular for the boys, and allotment gardens, with a little out-of-door instruction in garden work and manures, and account keeping at Lilleshall, and I got them every year to bring me a balanced debtor and creditor account of their allotment gardens, and they were able to answer such few questions as I was competent to ask about the manures, and about the course of cropping, if the word is not too grand, and how they cultivated their allotments during the year.

8521. The Commission have had under their consideration the question whether it may be expedient in some of the great centres of manufacturing industry, such as Birmingham or Wolverhampton, to establish scientific schools of an elementary character, but adapted to spread a knowledge of elementary science among the artizan and adult labouring population and youth; and it has been suggested that either a third year's training might be given in the training colleges, or that the pupils in the training colleges, living a third year in those colleges, might attend some central school in London or elsewhere, and during that third year might devote the principal part of their time to acquiring a knowledge of the elementary sciences, with a view to becoming the teachers of elementary scientific schools in those centres; have you, from what you observed of the progress of elementary education in the districts which you inspected, any hope that such schools could, at an early period, be developed, if the class of teachers were created?—Undoubtedly, because I have seen it done at Bristol with the very best results. At the same time, I should take exception to the plan by which you propose to produce your teachers. I should deprecate very much, indeed,

sending a youth in his third year (that is, in the 20th or 21st year of his age) up to London. It is difficult enough to govern them and keep them all right within the four walls of a college; but to send him up, say from Saltley or Chester, or wherever his training college might be, to take lodgings in London, in order that he might attend lessons in chemistry, would be the high road to breaking him down morally.

8522. The idea of my question was, that certain colleges that are in London, as, for example, Battersea, Saint Mark's, the Wesleyan Training College in Westminster, and the Borough Road, taking charge of their scholars for purposes of discipline and moral guidance, might, in the daytime, send their pupils of the third year to a central school of science in which they might receive the instruction which I have described; not that the pupils should be sent up from the country to London to live in lodgings, but that if the training colleges were placed anywhere near such a college as Owens College at Manchester, or Durham University, they might avail themselves of the scientific instruction which might be given in that College or University, and my question was whether, if teachers, with high moral qualifications and certain respectable scientific requirements, were produced, they would find work in the centres of manufacturing industry?—I should think so, judging from the great success of the Hull Navigation School and the Bristol Trade School, and the school in connexion with the Mechanics' Institute at Manchester. There is a great opening just now for schools that would touch the elementary schools on the one side, and touch the Royal College of Chemistry and the Royal School of Mines on the other—intermediate schools of technical instruction, filling up that large gap, are very much wanted.

8523. And what amount of apparatus, if there was any, was there connected with any of the evening classes or day schools in which any elementary scientific instruction was given in your district?—Most of them had the cabinet that you are familiar with that was sent out by Downing Street in those days with a 5*l.* grant. Most of them had that cabinet with its chemicals and apparatus, by way of a beginning of a laboratory, and some of them made and were encouraged to make little local museums, mineralogical and geological.

8524. Were there any chemical laboratories or laboratories of experimental physics connected with any of the institutions under your inspection?—Yes, there were.

8525. I mean with the mechanics' or other institutions?—In our evening schools, as I was saying, we started rather ambitiously, and in the case of some of those evening schools, before they had gravitated into the elements, we fitted them up with those cabinets, and with block-printed diagrams of machines, and so forth, to a great extent.

8526. (*Professor Huxley.*) I understood you to say just now that you did not consider the teaching of elementary science altogether a good means of educational training. Will you kindly state your reasons for that opinion?—I am not aware that I said so. I should deprecate the introduction of any systematic instruction in science, or in applied science, into the time table of an elementary school; first, because there is no room for it, and something would go to the wall; and, secondly, because I think it would tend, in most of our teachers' minds, to confuse their aim. Their aim is education, and if you give them many matters of technical instruction, you confuse their aim.

8527. That is precisely the point to which my question was directed. I understood you to object to it before upon the ground that the business of a teacher was with education, and the implication, I think, is, that elementary science would not afford education?—I do not mean to commit myself to that last proposition. I can well conceive that it is an admirable educational instrument, but not in an elementary school.

8528. Do you not think that there may be some little confusion as to what you and I may mean by the

Rev. Canon  
Norris.

16 May 1871.



Rev. Canon  
Norris.

16 May 1871.

word "science?" I do not for a moment suggest the teaching of technical science to young children, but what is, in point of fact, a carefully systematised and methodised object lesson; and it surely must be perfectly easy to give an intelligent comprehension of the rudimentary phenomena of nature to young children?—Yes.

8529. And by making that training substantial, real, and definite, so far as it goes, while keeping perfectly clear of everything technical, it may be possible to convert such teaching into a great educational instrument, as well as a means of communicating mere information. Would you object to that view of the case?—Yes, I should, in an elementary school. I am confining myself entirely to the boy or the girl under 12 years of age in an elementary school. If you introduce this systematically, you would push out what is more important.

8530. Do you think that instruction to the extent of one or two hours a week in the elements of science might not be given without pushing things out which are of greater importance?—I think that they might well ground children in the elements of reading, writing, and arithmetic, which are the tools of their after education, and have two or three hours a week to spare; but I should wish to employ those two or three hours a week otherwise.

8531. May I ask how you would wish to employ them otherwise?—In humanity, distinctly, rather than in physical science, as being a far more important matter.

8532. In what form of humanity?—Biography for young children is infinitely more important than chemistry.

8533. Do you think that a young child can form a clearer idea of what is the meaning of biography, than of what is the meaning of a scientific fact?—In the one you are speaking to the child's heart as well as his head, in the other you are only speaking to his head, and I would rather speak to both. In your manuals of physical science the little words "love," "hate," "fear," and "hope," which occupy a large portion of that child's mind and heart, do not occur, and I would rather have some subject in which they did occur.

8534. Do not you think that a scientific training gives a child some better idea than he might otherwise have of what he ought to love and hate, and so on?—No, I think not.

8535. Have you had any familiarity, yourself, with the teaching of science, or have you turned your mind to scientific study at any time?—Only by way of recreation. I have always been fond of machinery and of going down coal pits, but my knowledge is only of a popular kind.

8536. (*Mr. Samuelson.*) In those schools in which the elements of science were taught, or partially taught, was the instruction in reading, writing, and arithmetic inferior to what it was in those schools in which no attempt was made to teach science?—No; I do not remember that it was; on the contrary, the very fact of an attempt being made to teach something of natural philosophy indicated that the teacher was a superior man, and that the teaching throughout was good.

8537. In your opinion, the superior character of the teaching was due to the character of the teacher, and not to the intelligence of the children being awakened by the additional subjects which they were taught?—It was chiefly due to the fact that they had in such a school probably a superior teacher, but also I think that his lessons in the allotment garden, or by the road side, or on the Saturday walk, or whatever they might be, were awakening the general intelligence of the children undoubtedly, and making them more accurate observers and more patient thinkers than they otherwise would have been.

8538. If that could be done in all schools by competent teachers, you would consider it an advantage?—Yes, distinctly.

8539. (*Sir John Lubbock.*) Reading, writing, and arithmetic, in themselves, I presume, are not educa-

tion at all, but only the means of education?—Merely the tools of education.

8540. Therefore, if you turn children out of those elementary schools, merely having made them good readers and writers, without any other result, you would not fulfil what you have yourself laid down as the main objects of schools?—No.

1541. Do you not consider that the younger a child is the shorter the lessons should be?—Yes.

8542. The mind is easily wearied, and they can be taught more, can they not, by having a succession of subjects, than they could if they were kept for any considerable time upon one line of thought?—Yes.

8543. That would be, therefore, a strong reason for a certain amount of variety in the time table of elementary schools, would it not?—You might ring changes on three subjects, and never go on with any one of them for more than half an hour. You need not introduce six subjects in order to shorten the lessons on each to half an hour.

8544. When you say three subjects, do you mean reading, writing, and arithmetic?—No, I merely meant to illustrate my view.

8545. Of course, reading and writing would be consistent with any other subject; in teaching reading at the same time you might teach biography, or you might teach some elementary science, or any other subject, might you not?—Yes.

8546. In fact, a child must be reading something, and whatever other subject is being taught at the same time, the two must necessarily go together?—Nearly always; not in arithmetic.

8547. I am now confining myself to reading and writing; arithmetic I take to be a subject of education as well as a means of education, because it does give the mind a grasp of one subject of human knowledge; that is to say, of numbers?—Yes, and it is a subject of intellectual education.

8548. Reading and writing, on the other hand, are merely the foundation—the means of acquiring education?—Yes, they are arts, they are the means rather than the end. Of course, there is a little science in arithmetic as well as the art of cyphering.

8549. But as far as reading and writing go they are mere arts?—Yes.

8550. Therefore, the object lessons, which I understand you to approve of, might very well be given, might they not, in conjunction with the reading lesson, in fact the object lesson and the reading lesson would be the complement of one another?—Yes.

8551. I do not, therefore, quite see why you should object to them in a school in a reading lesson, if you approve of them in a walk on Saturday afternoon?—Anything you can introduce into the reading lesson is to the good, and any awakening of the general intelligence; but, as I have said more than once, I would deprecate introducing into my time table anything that would be sure to be pushing out something more important.

8552. But if you introduce reading into the time table, without specifying the subject of reading, is not that practically extremely vague?—It is what is usual. Our reading books are graduated according to to the age of children, and they contain lessons on nature, and lessons on biography, and lessons on history, tales of fiction, and so on, in great variety. It might be well to increase the scientific element, perhaps.

8553. (*Sir James P. Kay-Shuttleworth.*) The Irish school books do contain, do they not, both the scientific element, and also the element of political economy?—Yes, they do.

8554. (*Sir John Lubbock.*) The object of my question was rather this: you state, in the time table, that a given half hour is to be devoted to reading; that announcement is generally considered to be a specification of the subject in which instruction is to be given during that half hour; but it appears to me that it only covers half the question, because it makes all the difference what is to be read?—It does in the



first class, but in the lower classes it is spelling and the construction of words to a great extent.

8555. I understood you just now to attach very great importance to biography as tending to develop the affections; it would surely be perfectly easy to have an amount of biography introduced, as, in fact, is done in the early lesson books?—Yes.

8556. In fact, without in any way interfering with the reading, it would be easy to introduce a certain variety of subjects into the reading, would it not?—Yes.

8557. And such objects as would naturally be introduced into most elementary reading books would not in any way be beyond the comprehension of children in the schools at the age of seven or eight, would they?—They ought not to be.

8558. Do you not think that they would increase the interest that would be felt in those books if they dealt sometimes with explanations of certain physical phenomena?—Yes, as they do.

8559. How would increase the interest, would it not, which the children feel in reading?—Yes; but there is no need of any change. I think that most of our common reading books do that.

8560. But, as there is a considerable variety in the common reading books, do not you think that it would be well to specify, rather more than is at present done, which of them should be used at particular times?—No, I think not; it is best to leave that to the teacher.

8561. But if you leave that to the teacher, you only examine practically in the art of reading, and not at all in the education which I understood you to say was a totally different thing, and the main object for which the school was established?—Education is different from instruction, as the whole differs from the part. I do not mean that the one was necessarily exclusive of the other.

8562. But as examinations in schools are carried on at present, the examination is simply in the art of reading, and not at all in the instruction which has been derived from what was read?—I used to give a very bad mark if they read unintelligently. I could nearly always tell if they had not been questioned in what they read; it was not altogether a mechanical examination.

8563. But, under the Revised Code, it has tended to become so, has it not?—I am speaking of examinations under the Revised Code. In the higher standards I used to refuse to pass children who read with admirable mechanical precision and fluency, and yet with no propriety of emphasis, showing that they had not been questioned in what they read, and did not understand it.

8564. But you did not ask any special questions tending to ascertain whether they had been instructed in the subject of the book that they were reading?—No; but when I found them reading unintelligently I turned round to the teacher and said, "Have you questioned them in this? Have you been in the habit of getting them to reproduce what they have read?" but I did not say, supposing the lesson was about a steam engine, have you given them instruction on the steam engine?

8565. Or on the nature of steam in any way?—No; my immediate work was reading, and if anything was unintelligently read, I inferred that the teacher had not got them to reproduce their reading.

8566. But you would see no difficulty, I presume, in combining a lesson in the elements of science with a lesson in the mechanical art of reading?—No, I would not have any such combination. I should deprecate it very much. I should be extremely sorry to find a teacher giving a lesson in any subject of applied science during the half hour that was set apart in the time table for reading.

8567. But if he gave no such lesson, would not the reading become a mere mechanical art, which I understood you to deprecate just now?—I used to have, 20 years ago, teachers who were brimful of all the ologies, and in their reading lessons went in *omnia*

*alia*; and the result was such as you and I should have deprecated at once.

8568. But you would not call that systematic instruction; it was rather the vague and general introduction of a variety of topics?—Systematic instruction I should have deprecated still more, for the reasons that I have already stated. I understand that you are now trying to ascertain what can be given incidentally, and construing the word incidentally to mean, particularly in the reading lesson, I should not only deprecate any systematic instruction in applied science, but I should deprecate making use of the reading lesson to give indirectly instruction in applied science.

8569. (*Mr. Samuelson.*) Have you visited any of the Swiss or German elementary schools, and heard a reading lesson given in those schools?—Neither in German Switzerland nor in Germany, for the very good reason that I should not have understood it myself. In France I have, but I have only once in my life been in Switzerland, and in German I am not competent to follow a lesson.

8570. (*Dr. Sharpey.*) With reference to the two or three hours a week which you think might be spared from the essential business of an elementary school, I think you stated that you think the time would be better bestowed in teaching biography than the rudiments of science?—I should say both if possible, but certainly biography, which is of human interest; for what is of human interest is far more important towards education, properly defined, than what is physical.

8571. But do you not think that the personal aid of a master is far more important in teaching the rudiments of science than in teaching biography, inasmuch as the children might by reading from their books gain what was required in biography, whereas it would be far more difficult by mere book reading to obtain any insight into science. Without presuming to differ from you with reference to the relative advantage of a knowledge of biography, as compared with a knowledge of the rudiments of science, I would ask whether, supposing they were equal at any rate, it would not be more important to use the aid of a teacher and the opportunities of a school to give instruction in elementary science rather than in biography, because the former is more difficult to obtain in any other way, and if once a boy has left school, he might have no further opportunity of knowing anything about it?—Yes; I am quite of opinion that a boy would find it more easy to educate himself in such a matter as biography in after years than he would in scientific subjects.

8572. Of course I do not speak of applied science; I mean the rudiments of science?—Yes; the rudiments of what used to be called natural philosophy. My old Cambridge recollections and my Aristotle reading have given me the habit of using the word science in a much larger sense than that in which you are using it, but I understand you to mean *natural* science.

8573. I mean, for example, physics, chemistry, and natural history—what the Germans call "*Naturwissenschaft*"?—Precisely so; not the science of logic, for example, or geometry.

8574. (*Sir James P. Kay-Shuttleworth.*) Looking to the opportunities for improvement which the new Education Act may give, by, in the first place, increasing the regularity of the attendance of the children, and probably prolonging ultimately their school age, and securing a better educated and a more complete staff of teachers in the schools, would you not think that that altered condition might give an opportunity, under proper stimuli to the teachers, to introduce certain well-selected elements of those parts of science which apply to the improvement of the condition of the working classes in their habitations and in their occupations, in their freedom from superstitions, and in restraining them from habits which are injurious to their health?—It is my hope, and it is my belief, that the recent Act will increase the regularity of the children, and enable

Rev. Canon  
Norris.

10 May 1871.



Rev. Canon  
Norris.

16 May 1871.

us, therefore, in the elementary school, to do more than we have done; but there are many other claimants outside the door of the school waiting for admission, which I, for one, value more than applied science, and I should wish to admit *my* friends before *your* friends. I should wish to introduce those several subjects that are waiting outside that have more to do with what I call the heart of the child, I mean that tend to make the child not only know the right but love the right, and not only know the wrong but hate the wrong. I should wish to teach him early to know something of those forces which for good or evil act upon the human will; and so stir within him some feeling for what ennobles life; for this I would willingly postpone awhile the knowledge of nature's forces. The latter should follow, if possible, but first and foremost what is of moral interest and human interest.

8575. Take one single province of such instruction which has been commonly called in the syllabus, only too vaguely called, economy, meaning domestic and personal economy, would you think it more fitting that it should be the elementary school or the secondary evening school which should give instruction of this kind, namely, the sources of injury to health from impure water, from defects in ventilation in dwellings, from want of cleanliness, from imperfection of drainage, from various bad habits of life as respects food and cooking, intemperance, and what not; as to the mode of the propagation of infectious diseases, and the securities that may be obtained against them by various expedients which are known to physicians, particularly vaccination—would you think it should be in the elementary school, or in the evening school, that those obvious and ultimately absolutely necessary elements of civilisation should be made known?—Not in the elementary school by systematic instruction therein; but I should wish the teacher of the elementary school to have gone through a course of instruction bearing upon those subjects which you have specified; and I should wish that teacher, incidentally and indirectly, to interest his scholars in those matters, but not as a substantive part of the school work.

8576. I think you would admit, probably, that at the very basis of morals lies obedience to natural laws?—That seems to me about the last result that a thinking man attains to. It is a very important result; but one that I should rather put at the top than at the bottom of the educational ladder. I should not begin with a child in that way. I perfectly subscribe to your proposition, but it is certainly one that I did not attain to in my childhood. If you had put it before me as a child, I should not in the least have understood what it meant.

8577. There are obviously certain natural laws, are there not, which are inseparably connected with our physical well being?—Yes; but a child obeys the law before he understands the law, and does so best. Chronologically, the reason for it comes last; logically it comes first, I quite agree; but chronologically it comes last, I think.

8578. Then your view would be that you would rather set about improving the habits of the adult population, than seeking by any form of instruction to make it apparent to the entire population that it was reasonable that those habits should be improved?—I would rather sum up my experience by saying that it has led me to put very little faith in school lessons apart from lessons of life. There is a passage which I remember in Hooker, and which you well remember, I daresay, where he speaks of education and instruction, the one by use and the other by precept, giving wisdom. I have more faith in the use than in the precept. I have very little faith in the precept unaccompanied by what Hooker called the use.

8579. I think you said a little while ago something with respect to the Black Country and the extreme ignorance of the miners, which was a hindrance to their taking any interest in instruction in the mode of avoiding dangers, and to the use of expedients by

which danger might be avoided?—I seem to put it the other way, that if “the use” in the coal mine, the processes of getting the coal, were more scientific, then the precept or the instruction would follow; but I thought that the use would govern the precept, rather than the precept engender the right use.

8580. Do not you think it would be more easy for an intelligent man, who know the danger, to abstain from lighting his pipe from his Davy lamp in a mine in which there was what is commonly called firedamp?—I doubt whether he would begin to reason about it till he had blown himself up.

8581. (*Sir John Lubbock.*) At what age do you consider that children generally could pass the first standard in the elementary schools?—The first standard under the New Revised Code, I understand you to mean, which is a peg higher than the first standard before this year. A child might pass at seven years old, I should say.

8582. That is to say children at present?—Yes.

8583. I understood you to say that you thought it might be desirable, having reference to the short time during which children could keep their mind upon one subject, to introduce two or three subjects of instruction in the school, as well as reading, writing, and arithmetic?—I think I said that there would be two or three hours to spare in the week for such extra subjects. I think the time has now come when we may rather retrace our steps and give a little more culture as distinct from instruction in the mere arts.

8584. You mentioned biography as one subject which you would wish to see introduced, will you also say what other subjects you would give the preference to?—Geography. Our old familiar lessons in geography I have never ceased to regret. I have seen the necessity of lessening the time given to geography under the Revised Code, but I am quite hopeful now that we shall resume it. By geography I do not mean physical geography principally or in any large measure, but rather as much geography as shall give them an intelligent interest in a newspaper.

8585. Do not you think that a knowledge of physical geography would give them an interest in a newspaper as well as plain maps?—By all means if you have time for it. But teach them what is necessary to an intelligent reading of their penny paper first. Let physical geography follow; but let them know something about their cousins in Queensland or Canada at once.

8586. The geographical position of Switzerland in Europe is a question of pure geography, but the mountainous character of Switzerland is a question of physical geography, is it not?—Yes.

8587. Is it not necessary in order that they should understand their paper that they should be aware of the peculiar character of Switzerland?—Yes, that is desirable.

8588. Therefore, the one and the other are very much interwoven?—Yes. I want to hang the walls again with maps, and during the reading lessons I want them to refer to those maps. In the fifth and sixth standards the master often does bring in his daily newspaper, and gets the first class to pass it round and read it aloud. I should like to have reference to maps, and along with reference to maps I should like the children to do what they are all very fond of doing, namely, copy them; and I should wish to do this before I began physical geography; and, that done, I doubt whether I should have much time left for physical geography.

8589. Is not the danger of a map rather that a child should suppose that the country is flat with the rivers meandering causelessly about it?—I should be content with his notion of a flat country for awhile.

8590. But only for a short while, I should think?—I should not object to that continuing till the child was 10 years old, he is sure to correct it afterwards; his first journey to London will correct it.



8591. You think you would teach geography without any introduction of the physical portion of the subject?—An intelligent master would be sure to say something by the way that would throw light upon it; but I should wish first and foremost to teach geography for the sake of its bearing on our fellow men, with reference to his uncles and cousins, and so on, who have gone to the colonies, and so forth.

8592. Has not physical geography as much as mere plain geography a bearing upon the condition of our fellow men?—Undoubtedly it has; only it is a question of priority which one would begin with, and I would rather begin with the other, and go on with physical geography if there is time for it, than begin with physical geography, leaving what I apprehend to be of more importance to follow, if there is time for it.

8593. You do not think that by the separation—by teaching geography without any physical geography, there is a tendency to give an entirely wrong idea as to the nature of geography itself?—I should certainly wish my master to understand physical geography thoroughly, and then I think he would not mislead his scholars in his lessons on political geography.

8594. Then he must introduce physical geography?—Yes.

8595. Therefore, you do not look upon the distinction between the two as a fundamental or a very broad distinction?—No. In the time table I should write up geography, I should not say physical geography.

8596. Then you would include both the position of a country and its general features?—Yes; a wise man, I think, would begin with the situation of places; how far physical geography should be introduced might be left to the teacher.

8597. Would not the separation of the two be prejudicial as they are so interwoven?—Yes.

8598. Biography and geography would be two subjects: will you mention one other which you would recommend?—A boy could hardly be interested in biography unless he knew something of English History and of general history—history being to biography what the chart at the beginning of an atlas is to the maps that would follow.

8599. You would consider an elementary school which did not include some of those subjects as one which very imperfectly fulfilled the object for which it was established?—Yes; I am speaking now of our future, after this recent Act has been at work some time. At present, I certainly should not so judge. On the contrary, taking our schools as they now are, I should think it a very wrong inference that a school is doing its work imperfectly because those subjects are not taught. But, as Sir James Shuttleworth said just now, it is our hope that after a few years' operation of this Act we shall be in a much more luxurious condition for cultivating a child's intelligence than we are now.

8600. (*Mr. Samuelson.*) What is there in the Act which should raise this distinction between present and future schools?—It is Mr. Forster's hope that the action of the School Boards will be both direct and

indirect—direct where there is a School Board, indirect where there is none, in raising public opinion and public appreciation of education; at least, I apprehend so, and in both ways we shall be helped.

8601. But does not it merely signify that a great number of persons will consider it to be desirable where a few deem it to be so now?—There will be an extension of quantity and of quality also; not only a dozen parents wishing for education where one desired it before, but that dozen wishing for a better kind of education than the one did, and willing to send their children to school more regularly.

8602. I suppose it would be chiefly with reference to the irregularity of attendance that you think that not much more work can be done now?—Yes, that, and also the early age at which they leave school, hinders it at present.

8603. But would not there be another question as to what should be included in the higher standards?—More children would reach the higher standards if the children remained at school longer, and it would be better worth while to introduce those subjects. As I came up in the train this morning, I asked the manager of a school in Surrey how many of his children reached standard 6, and he said, "None." How many standard 5? and he said, "Very few, nearly all leave in standard 4." Therefore, there is hardly any room in that school for any of those subjects that we have been talking about. But, taking the same sanguine view that Sir James Shuttleworth takes, and which I share, of the probable operation of the new Act, I am hopeful that our children will stay till 12 or 13, as a rule, and then we may do more with them.

8604. But, wherever there is a fair number of children who stay to the advanced age, there is no reason why extra subjects, such as you would like to see introduced, or such as others would like to see introduced, should not be at once taken up?—No reason at all.

8605. (*Sir John Lubbock.*) I should like to have your opinion with reference to the proportion of children who will be able to pass the new standard for reading, writing, and arithmetic, and my question has reference to the amount of money which a schoolmaster might reasonably expect to get under the New Code?—It is seven years since I was an Inspector of schools. I have not worked as an Inspector under the present Code, and I doubt whether I could give you any answer that would be worth your having.

8606. (*Chairman.*) Have you examined the provisions of the New Code?—Yes, I have examined it carefully. I am the manager of a school under it.

8607. (*Sir John Lubbock.*) Will you have the kindness to state to the Commission whether you think that the schools, generally, will be able to obtain the whole of the 15s. allowed under the New Code without going in for the extra subjects?—Yes, I do; and I think that a larger proportion of schools may, under the existing Code, obtain the maximum grant than is quite compatible with the stimulus supposed to be afforded by the principle of payment by results, and the cultivation of the higher subjects.

The witness withdrew.

The Rev. FREDERICK WATKINS examined.

8608. (*Chairman.*) You have been for many years, and still are, Inspector of elementary schools under the Education Department of the Privy Council?—Yes, I have been so for 27 years.

8609. Has any instruction in elementary science been given in any of the schools which have come under your observation?—Hardly any regular instruction.

8610. Can you describe to the Commission to what extent science has been taught in any of the day schools?—In the day schools with which I have to do it is hardly taught at all. It is only taught in the reading lessons in the elementary books on certain scientific subjects, but those lessons are merely read over; there is no direct and regular course of instruction given.

I do not think I can name a single daily elementary school where there is any direct and continuous course of instruction.

8611. Do any of the masters take advantage of those reading lessons in order to give their pupils some further instruction in the elements of science?—Very rarely, indeed, for the plain reason that they think they have no time to do it.

8612. It is the habit usually, is it not, for the master to question his pupils to a certain extent upon what they had been previously reading?—I doubt very much whether it is the habit.

8613. Do not they take any means to ascertain whether the scholars understand what they have been reading?—In a great many cases I am quite sure they

Rev. Canon Norris.

16 May 1871.

Rev. E. Watkins.



Rev. F.  
Watkins.

16 May 1871.

do not, in other cases they do; but in the lower classes especially they do not, and, as a general rule, for the same reason, the want of time. They allege that as their excuse.

8614. (*Sir J. P. Kay-Shuttleworth.*) Was there not a time, when in the best schools, it was more general that they should give such questions on the meaning of what they read?—I think before the Revised Code came in, in the upper classes, where, what we call, the higher subjects were taught, that is, geography, grammar, and history, there was more questioning then, and a more intelligent knowledge than there is now.

8615. At that time there was a greater effort, was there not, to cultivate the general intelligence of children by making them thoroughly understand what they read, than subsequently has been the case, or rather the teachers have acted more under the necessity of acquiring a technical knowledge of reading?—I have no doubt of that myself.

8616. (*Chairman.*) Are you of opinion that instruction in science could be with advantage introduced into elementary schools to a greater extent than it is at present?—It would be the merest elements of science in the world. A foundation might possibly be laid, but it could hardly go beyond that.

8617. Do you think that such a foundation could be laid with advantage in elementary schools, and do you think that it would be a good class of subjects for teachers to instruct their boys in?—Dependent upon the character of the school, I think it would. You must vary your subject with the locality, and with the class and character of the school.

8618. What subjects do you think could be introduced with advantage in the scientific instruction of elementary schools?—I should say that in all schools there should be some of the elements of physiology, and I should say that in all schools there should be some of the elements of geography, and that geography led out into the topography of the locality, as applied geography; and in town schools I should like to see something of the elements of chemical science. In country schools, I think, in agricultural districts, something might be done in botany and agriculture, and in all girls' schools something of domestic economy.

8619. Do you think that any steps in that direction could be taken with children under 13 years of age?—Yes.

8620. At what age do you think such instruction might commence?—That would depend much upon the book that you put into their hands, and the teacher that explains the book to them; but, with a good teacher and a good elementary book, certainly from 10 to 13 you might lay the foundation of scientific knowledge.

8621. I think I understood you to say that there are none or very few schools in which anything of the kind is attempted at present?—In which anything is done regularly or continuously. There are chapters on scientific subjects in the small elementary books, and they come in the course of reading, but they pass away very much as the other reading passes away.

8622. Have you any examples in your district of elementary schools that are far beyond the ordinary standard in the number of subjects taught?—The good schools generally teach something of geography and grammar; the bad schools do not get beyond the three R's, as they are called.

8623. There has been no direct encouragement under the Revised Code to teachers to instruct in geography or grammar?—Rather the contrary, till Mr. Corry's Minute two years ago, which gave a premium for special subjects. Under the New Code lately issued there is very considerable prospect of encouragement given in the 4th schedule. It comes under the head of "one or more specific subjects of secular instruction," for which a payment is made of 3s. per head for each child who passes in two subjects. It says, "It is not improbable that new plans may be proposed by which children may

"be enabled to gain scientific ideas from the study of natural objects, and from careful direction of their power of observation. Such plans would necessarily differ in town and country, and the suitability of each to the school in which it is adopted must be a matter of discretion." That holds out, I think, a very fair prospect of something being done in that direction, because, not only will the subject be taught, but the school will get paid for the progress in it.

8624. How far do you think that the 3s. for the extra subjects will really operate, because the maximum that any school can receive under the Minute is on the average 15s. per child?—Yes, for every child in average attendance.

8625. Will they not be able to earn that 15s., as a general rule, without paying any attention to those extra subjects?—I think hardly. No doubt that limitation to 15s. will cut off a good deal of the grant that might be gained otherwise.

8626. By attendance and by passing in the regular subjects of reading, writing, and arithmetic, the total amount would be 18s., would it not?—Yes.

8627. Do you think that a large proportion of children in general would entitle a school to that 18s.?—That depends upon the school. In good schools, the children pass in all three subjects. There are certain schools where every child passes in all three subjects, but it is a very rare thing; there are not, perhaps, half a dozen schools in my district where that could be done.

8628. Half a dozen out of how many?—At this moment I can only remember four schools where that could be done. I have just had a great number thrown into my district. I hardly know the number, but I should say about 250 separate school places, many of them having three departments. I cannot quite say, for the district has been altered so much, that I hardly know what the exact number is.

8629. Do we understand that in not above two per cent., or something of that kind, out of all the schools, would the children be able to pass in all those three subjects?—A good many will pass in all the subjects in every tolerably good school, and there are schools where they almost regularly all pass.

8630. Would you consider it a bad school where less than one half passed in those three subjects?—Yes; I always make special mention of it where that is the case; in fact I recommend that there should be a deduction from the grant.

8631. Where three fourths passed, should you call it a fair average school?—Yes.

8632. Will there be much difficulty in earning the 6s. for attendance?—No, the number of attendances required is increased, as no doubt you are aware.

8633. But do you think that that will limit the amount earned under that provision?—It has at present. As far as the New Code has acted, it has limited the number; the numbers presented have been considerably smaller, but I look forward to that as a pressure which will make the children attend more regularly.

8634. Have you also inspected the evening schools in your district?—Yes.

8635. What is the character of the instruction in those schools; is more instruction of a scientific character given than in any of the day schools?—Not in those that I have inspected. It is very elementary instruction, indeed, and they are rather on the whole below the character of the day schools.

8636. I presume that the boys attending those evening schools are older than those in the day schools?—Yes, they are older; but they have very often had very little instruction, indeed, in a great many cases.

8637. Is the instruction given there rather to be considered as a substitute for what might have been received in the elementary schools, than as carrying their education on to a further extent?—In some cases it is simply the beginning of their instruction; they have hardly had any at all previously. In others it is a determination to carry on what they have already acquired; but it would be rather difficult to say how



many belonged to the one class and how many to the other.

8638. What are the subjects taught in the highest class of evening schools?—They do not go at all beyond the elementary subjects in the great majority of cases. In such schools as I have had to do with—take the Sheffield schools, for instance—I do not think they have taken any extra subjects; there is nothing but reading, writing, and arithmetic in any one single school that I am aware of.

8639. Do not those who leave the ordinary elementary schools with a tolerable knowledge of reading, writing, and arithmetic, attempt anything further in the evening schools?—I do not think that we have any schools where they come and where they attempt anything further, at least I am not aware of any.

8640. Then nothing further is practically done in the way of scientific instruction in the evening schools than in the day schools?—Not as a rule, certainly. There may be some cases, but none that come under my inspection. We do not know all the schools; we only know a certain class of schools at present.

8641. (*Sir J. P. Kay-Shuttleworth.*) Your district is partly on the coalfield and partly on the ironfield of Yorkshire, is it not?—Yes.

8642. And does it include a portion of the Cleveland district?—No.

8643. Does it include Huddersfield?—No; I may say that it is the eastern part of the West Riding of Yorkshire.

8644. None of the mechanics' institutions have, I believe, been inspected by Her Majesty's Inspectors?—No.

8645. Are you aware, from your own personal inquiries, or otherwise, of the condition of the mechanics' institutions in the great towns of Yorkshire?—I could only speak from mere report.

8646. You do not know, for example, whether they have, connected with their classes of scientific instruction, laboratories and apparatus?—I do not know.

8647. Are you aware whether, in the mining district, either in the elementary day schools or in the elementary evening schools, or in any other form which may have been brought indirectly even under your cognizance, instruction is given of a nature to warn the miners as to the character of the inflammable gases in mines, and the best means to prevent explosions, whether by ventilation or by the use of the Davy lamp, or by other precautions?—Some of the elementary books in the day schools have such subjects in them.

8648. Have the teachers been accustomed to dwell on those subjects in the mining districts, that is to say, when such a chapter has been read on the nature of the inflammable gases of mines, have the teachers been accustomed to explain it to the scholars?—I am inclined to think not. One cannot speak with positive knowledge, because one is not present at the lesson; there are only certain lessons which one sees.

8649. What is your impression as to the competency of the certificated teachers at present employed in the day schools to give elementary instruction of that kind to the scholars?—It is rather difficult to answer positively, because the men are generally intelligent men, and there is no reason why, if they applied their minds to any one of those points, they should not succeed in it. At present, they do not apply their minds and give their attention to it.

8650. They have not had any direct instruction from the Education Department to do such a thing, nor have they any reward for doing it?—No direct reward.

8651. I need not ask you whether you think that it would be important that the elementary teachers should have both the knowledge and the capacity to give instruction of that kind in a mining district, and also sufficient stimulus to exert themselves in that direction?—I think it would be invaluable; I think it would save many a life.

8652. In your opinion would it be desirable, with that view, that there should be either some addition

made to the existing syllabus of the training colleges, or that some extension of the period of study should occur in training colleges in which scientific instruction could be obtained?—It would be very desirable that there should be the power of giving it in the schools. How it might best be conveyed to the teachers I cannot quite say. The great cry everywhere is the pressure for time. They have not time to do this or that; the subjects are so many, and they have so many requirements—that is really the cry—and I think to a certain extent there is a good deal of truth in it.

8653. That is to say, having a certain number of subjects in which they must acquire a definite proficiency, and upon which the payment now given by the Government towards the support of the schools depends, it is extremely difficult to add to those subjects others, whatever may be the wants of the civilization of the district?—Very difficult indeed.

8654. Taking such a subject as that to which you have made some allusion, namely, domestic economy, and analysing it somewhat, it is important that the population should, either in the day school or in the elementary evening school, become acquainted with the danger to health from the impurities of water, from imperfect ventilation, from imperfect drainage, from imperfect construction of buildings, from bad sanitary conduct in relation to habits of life, and from intemperance, and particularly as to the mode by which infectious and contagious diseases are propagated, and the precautions taken to prevent them; could the elementary school, or could the elementary evening school, be made the source of the diffusion of information on those subjects if there were competent teachers?—Yes, I think so; I think that encouragement must be given in that direction.

8655. Looking at the subject in another point of view, that which is purely educational, there is not much, at present, is there, in the instruction of day schools to cultivate the habits of observation of the scholars?—Hardly anything.

8656. Are there any teachers in your district who adopt a course of instruction, like that which Professor Henslow adopted in his schools, of cultivating habits of observation in the fields?—Yes.

8657. Could you give any examples of success in that respect?—I know cases where masters take their boys out in the fields and make them gather flowers and make collections of wild flowers, and that certainly has had a good effect. The children both get fond of flowers and they get the habit of observation.

8658. Have you known that plan, either with respect to a day school or an elementary evening school, carried out to matters of geological observation?—I think not at all to geology.

8659. In no evening school, in your district, from your knowledge, are the youths induced to bring fossil specimens to the teacher to have them explained?—No, I think not.

8660. Constantly on the mine heaps there must be an abundance of fossil specimens under their feet unobserved, but they have neither the knowledge, nor the intelligence, nor the curiosity to examine them and bring them to the teacher for explanation?—No, I think not.

8661. And is there nothing at present operating to induce such habits of observation?—No, nothing.

8662. With respect to mechanical contrivances, you are as well aware as I am that almost every contribution, until within very recent years, to the mechanical contrivances in the textile trade has come from the operative population; is it not very important, seeing that mechanical contrivances are becoming extremely more complicated, that in the elementary evening schools, at least in a secondary school, some knowledge of the elements of mechanics should be given?—You must remember that an evening school is hardly to be called a secondary school; it is really as much an elementary school as the other at present. It is by no means in advance of the day school in general; in fact, I should say that it is, on the whole, rather

*Rev. F. Watkins.*

16 May 1871.



Rev. F.  
Watkins.

16 May 1871.

below the day school in intellectual character and power.

8663. Are you aware that in East Lancashire they have, to a very great extent, grafted upon their elementary evening schools science classes, under the Science and Art Department, with more or less success, with the use of apparatus and specimens?—Yes.

8664. Is anything of that kind going on in Yorkshire?—Not in my district. Sheffield has the character of being rather behind the other manufacturing towns; I do not know whether it is true or not.

8665. The first step in the whole of this matter, if we are to make any improvement whatever, would obviously be in increasing the knowledge and capacity of the teachers and their incentives to place themselves under specific instruction?—Yes, you must have an incentive.

8666. If, therefore, there were in the principal centres of industry, on the coal fields or on the iron fields, the means in those schools in which elementary scientific instruction could be given with proper apparatus and laboratories by competent teachers, do you think there would be a resort of students to them?—One would think so, but I do not know that my opinion is worth having at all upon that subject. I think it would be very well if you could have some such schools as those, where you could draft off the cleverer and more intelligent lads, and the lads who had made most progress in the subjects of the common daily school.

8667. Have you ever given your mind to the question, which is very interesting, whether a larger amount of success could not be obtained in the infant school in preparing children in the art of reading and writing in a shorter time by its being done in a better way, and are you acquainted with some successful infant schools which have been established in Switzerland and other parts of Europe?—I have not seen them for many years.

8668. (*Professor Huxley.*) Could you tell us how much an ordinary elementary school in your district could earn, supposing that there were no 15s. limit, that is to say, supposing a school were allowed to take extra subjects and to earn as much as it could?—Ordinary schools do not go very largely into the extra subjects; an ordinary school rarely has more than one extra subject.

8669. I am not speaking so much of the actual practice now, as of what might be done if the 15s. limit did not exist and operate as a check?—I do not think that it operates as a check at present, or if it does practically check, it does not I think prevent teachers from taking the extra subjects.

8670. Do you think that they would take them without being paid for them?—My impression is this, that every ordinary school after a little time ought to pass all its children. There would always be some few who fall short, but they ought to pass the great majority of their children in all three subjects; and besides that an ordinary school ought at least to pass the 4th, 5th, and 6th standards in one of the extra subjects, and that would make 21s. for each passer.

8671. So that, in fact, this limitation does cut off on the average somewhere about 5s. or 6s. per head from each school?—Partly so, but I do not think you could expect two extra subjects in ordinary schools.

8672. (*Sir James P. Kay-Shuttleworth.*) The cost of a school is mainly dependent on the cost of the staff, as, for example, the salary of the master and the number of pupil teachers or assistant teachers employed, in proportion to the children, and the salaries paid to them?—Yes, that would cover something like nine tenths of the whole expenditure.

8673. You could not expect to attain the highest degree of excellence without both efficient teachers and a sufficient staff?—No, certainly not.

8674. Consequently, to attain that degree of excellence a school must necessarily, on account of the expenses, be beyond the ordinary average; and might it not be that a school, to attain the highest excellence, should cost more than 30s. a head?—That would

depend upon the size of the school. A school of 60 children, with its staff, costs a great deal more in proportion than a school of 120.

8675. Take a school of 120 children. To attain the highest excellence, would not it very probably cost more than 180l. a year?—A school of 120 children would require a certificated teacher, and it would require three pupil teachers. The teacher would have at least 80l. a year, and the pupil teachers would average 15l. each, or 45l., in the different years of their apprenticeship; that is 125l. besides the schoolmistress, so that it would require 145l. for teachers alone, besides all the other expenses.

8676. (*Sir John Lubbock.*) In the case of a small school, or, indeed, of any school, do you not consider that a properly qualified master, assuming that the number of children was not too large, would be able to give them the instruction necessary to enable them to pass in the extra subjects as laid down in the New Code?—Yes, in a small school; but I do not know whether you understand by a small school an average attendance of from 40 to 50 children. It is very difficult for a master to be in two places at once, or to manage a much larger class well.

8677. Of course, if the master has 50 children he would require a pupil teacher; and the rule that you have laid down just now was, that it would be a fair thing to expect a master to take 30, and that there should be one pupil teacher for every 25 in addition?—Yes, that there should be a teacher for every class in the school, and that a class should not exceed about 25.

8678. My question was with regard to the capacity of the master for teaching the extra subjects, and not with reference to the number of pupils?—I think that every certificated teacher is quite able to teach the extra subjects which are taught now, that is to say, elementary geography and elementary grammar. All certificated teachers ought certainly to be able to teach them, and they generally are able to teach them; that is to say, they have the knowledge; whether they have the power of communicating the knowledge is a different thing, but they ought to get that knowledge at the training school.

8679. I think I understood you to say, that in a very good school every child might get the whole 18s. which is allowed for attendance and for the three primary subjects?—If I said every child I spoke rather loosely; there would be a few who would not.

8680. You would consider it satisfactory if there were about three fourths who succeeded?—Yes.

8681. Taking a school of 100 in average attendance, the maximum grant would be 1,500s., and supposing that one half pass in the three subjects, it would be 50 children at 18s.; that would be 900s. Assuming that one fourth of the remainder passed in two subjects, that would be 350s. more, and if the remaining one fourth got through in only one of the subjects, that is to say, 25 at 10s., that would bring up the grant to that school to its maximum. Therefore, supposing that one half of the children passed in all the three elementary subjects, and one fourth passed in the two special subjects, and that the remaining fourth passed only in one of the three subjects, then the school would get as much as it can get at all?—As a matter of arithmetic that is the case.

8682. And you say that in a satisfactory school three fourths ought to pass in all three?—Yes, all should pass, with few exceptions.

8683. If three fourths passed in the whole of the three, that would be 1,350s., and the remaining quarter need not pass in any one at all, because their mere attendance brings the school up to the whole amount of 15s.?—Yes.

8684. Therefore, under those circumstances I presume you would be of opinion that almost any school might attain the maximum possible grant without requiring to fall back upon the extra subjects for any pecuniary assistance whatever?—That is a fair school.

8685. A bad school, of course, is not likely to get anything for extra subjects, and, *à fortiori*, a good



school can get everything it can obtain at all without going in for extra subjects?—Yes, but it will not pass all the children in the extra subjects. The 15s. is a great limitation of the grant, there is no doubt about that.

8686. Therefore, if three fourths of the children pass in reading, writing, and arithmetic, and the remaining quarter do not pass in anything, still that school will obtain the maximum possible grant without any passing in the extra subjects?—So it seems.

8687. (*Mr. Samuelson.*) When you spoke of there not being time to examine the children in the lower standards upon what they had read, did you mean time for the pupils or time for the teachers?—I do not say that there is not time for the teachers. I merely say that they tell me that there is not time.

8688. Do they allege that they have not time to examine them, or that there is not time on the part of the children to be examined?—I do not see the difference myself.

8689. There is this, that the children may not be employed during the whole of their time, but the master or his assistant may be employed during the whole of his time?—I think it is both. I do not know that I could say exactly which it is; I think that the master fancies that he has other subjects to go and teach, and the children have other work to do. I do not think that the children are ever left unemployed in the school.

8690. Not even in the lower standards?—I think not, they are always doing something. The time table is drawn out regularly, and there is a certain subject for each half hour, or hour, or three quarters of an hour, whatever time may be given to the subject, and they are supposed to be doing it.

8691. But, however that may be, is it your opinion that if the teaching staff of schools were strengthened, there would be any difficulty in questioning the children, even in the lower grades, upon what they have read?—No, I do not think there would. I think they might economise their time a little more in some respects. I think that they very often read too long, reading a passage over and over again without examination in the subject, and I think that a shorter time might be given to the actual teaching to read and the practice of reading, and more given to the subject matter of the lesson.

8692. Without prejudice to their being able to pass in the standard of the year?—That is my impression; but I am not such a practical man as the teachers, who are every day in the school, and they say that they do not give more time than is actually needed. They must press those subjects, or otherwise they lose their grant.

8693. But, so far as you are able to judge, that would not be your opinion?—Certainly I do not think so. I think that they might do more in that way.

8694. Referring to the teaching of elementary science, I presume that the miners of South Yorkshire are men of ordinary intelligence?—The Yorkshire miners and the north country miners, those who come from Northumberland and Durham, are generally men of intelligence; the Staffordshire men and the men that come from South Wales are generally men below the average. That is what they tell me. I have not had much observation myself, but, from what I hear on all sides, there is a decided difference of character between the north countrymen and what one may call the lower miners—the foreigners, as they call them—who come from Staffordshire and from Wales, and who are employed in the Yorkshire mines more largely now than they used to be.

8695. But, notwithstanding any want of intelligence on their part, I presume that the miners themselves would be acquainted with the presence of explosive gases in the South Yorkshire coal mines?—I should think so.

8696. And that by exposing a naked light an explosion would be likely to occur?—Certainly I should think so.

8697. So that the mere fact of their being taught in the school would be no safeguard against the reckless course which those men pursue with regard to naked lights?—It would be no actual safeguard, it might have a tendency to diminish it. I should think that the more intelligence they have, the men would be less likely to act in that reckless way in which they do now. It is not so much ignorance as recklessness.

8698. It is your opinion that it is rather recklessness than want of knowledge which causes those men to run such frightful risks?—Yes, certainly.

8699. (*Sir John Lubbock.*) At what age do you consider that the children should be able to pass the first standard on an average?—Under the new régime it will be between seven and eight. They ought to pass it then.

8700. And many of them would pass no doubt a year sooner?—Some would. I am not sure whether I should say very many.

8701. I presume that we may hope that, when the attendance has been more regular, a larger number would be able to pass, and that the tendency of things is to make attendance more regular?—I think so, but I have a strong opinion that something more is needed.

8702. Do you mean more compulsion?—Yes.

8703. In the early portion of your evidence, you stated that you thought it would be difficult in elementary schools to teach anything more than the merest elements of science, especially as regards very young children; you would still probably consider that a knowledge of the elements of science is of very great importance?—Certainly.

8704. I mean that it is not at all necessary, for instance, that children should go deeply into astronomy in order to enable them to derive some advantage from a knowledge of the rudiments of astronomy?—No.

8705. To know, for instance, that the stars are material bodies, and not occult influences exercising a mysterious effect upon the destiny of men, is an advantage, is it not?—Certainly.

8706. I only wish to elicit your opinion that you intended no disparagement of the teaching of the elements of science?—No, very far from that; but I own that I do not see my way at present to anything like an intelligent teaching of the elements of science.

8707. Would you kindly say what you mean by intelligent teaching in that sense?—I mean, supposing that the elements of science must be taught in schools, it would be by having elementary books, and, first of all, the elementary books themselves are in a great measure wanting; there is hardly a class book written which would do for that special purpose. What I mean by intelligent teaching is, that when a lesson has been read by the children, the teacher should question it into them and question it out of them again; that he should make them realize the lesson to some extent, and that he should illustrate the lesson as far as he could.

8708. And you fear that that would be impossible under existing circumstances?—I certainly do. My impression is that there might be a great deal more intelligence in the common reading lessons in schools than there is at present. For many years I have reported over and over again that the reading lessons are merely reading, and nothing else.

8709. You would wish, then, to combine reading as one element of instruction, and the subject of the lesson as the other element?—Yes.

8710. Do you think that those two elements could be combined together without any injury to one another?—Certainly.

8711. And probably with great advantage to both?—No doubt.

8712. If they are reading at all they must be reading something; and it is very important, is it not, that they should understand what they are reading?—Yes; as a matter of fact, in reading the lesson over and over again they do not understand the words, and they cannot understand the thing unless they understand the words. I do not mean to say that they

*Rev. F. Watkins.*

16 May 1871.



Rev. F.  
Watkins.

16 May 1871.

are not able to give you any definition of a word, but they do not in general understand the meaning of the word.

8713. Having taught a good deal in village schools, that is entirely my own impression; but I do not see how you could arrive at a knowledge of whether a child does understand the words, unless you are teaching him something beyond the mere mechanical act of reading, and putting certain questions to him. Directly you put questions to him to ascertain whether he understands the meaning of what he is reading, you discover whether he attaches any meaning to the words, or whether they are mere sounds to him?—Yes; in a great many cases I think there is too much of that mechanical reading.

8714. Sir James Shuttleworth put a question to you with reference to elementary geology: do you think that the ideas which the children derive from reading the first chapter of Genesis, without any explanation, tend to prevent their intellect exercising itself at all upon the existence of fossils and the nature of geological formations?—I should not think so myself.

8715. Do you think that they have not mind enough to see the discrepancies between the two?—Very few children I should think have.

8716. In fact, you rather attribute the little attention that they pay to the existence of shells in gravel pits or chalk pits, or in the heaps of coal, to the want of their attention having been called to such subjects at all?—Yes, very much more to that than anything else.

8717. Do you not think that if their attention were called to the existence of those shells, and the impressions of leaves, and so on, that would awaken their minds and be a great advantage to them?—Yes, certainly.

8718. And you see no reason at all why that should not be done in elementary schools?—I see no reason why it should not be done if proper incentives were given. You must give some encouragement to the

teachers. You must put an object before them, because, under the present state of things, they really must work up those three subjects, reading, writing, and arithmetic, as their very existence depends upon it. Whether it is desirable to have it dependent so absolutely upon the effect of individual examination may be another question.

8719. At present there is very little, if any, inducement to schoolmasters to teach more than reading, writing, and arithmetic?—There is now, owing to the late minute, by the payment for special subjects.

8720. I think we have already seen that, owing to the deductions, such encouragement is really of an illusory character?—It certainly would appear to be so.

8721. (*Sir J. P. Kay-Shuttleworth.*) With a view to deriving the most successful results from the illustrative instruction which you conceive might be given during the reading lesson, would not that success very much depend on the knowledge which the teacher would have of the subjects taught, and the degree of intelligent activity which he evinced in giving that instruction to the children?—It must depend upon that.

8722. And, therefore, is it not, with a view to the introduction of the elements of scientific instruction, exceedingly important that the syllabus of the training colleges should include instruction in elementary science?—I think it is desirable.

8723. (*Chairman.*) Are there any training colleges in your district?—Yes; I have now the supervision of a larger district, which has just come into my hands, in which there will be four, two for men and two for women, namely, Durham two, York, and Ripon one each.

8724. Do you inspect them annually?—I shall do so for the future. I have inspected York for many years, and Durham for a year or two in the absence of the other Inspector.

The witness withdrew.

Adjourned to Friday next at half-past 11 o'clock.

6, Old Palace Yard, Westminster, Friday, 19th May 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE IN THE CHAIR.

Sir JOHN LUBBOCK, Bart., M.P., F.R.S.

Sir JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

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W. Ellis, Esq.

19 May 1871.

WILLIAM ELLIS, Esq., examined.

8725. (*Chairman.*) I believe you are the founder of the Birkbeck School?—As far as my money is concerned, I believe I assisted in establishing the original one, but the patron of it was the late Earl of Radnor, who was the proprietor of the buildings. I suggested it, I believe.

8726. How many years has it been established?—It was established in the year 1848.

8727. Were the Birkbeck Schools intended for the children of the classes who earn their livelihood by labour?—They were intended for all who chose to send their children there and pay 6d. a week.

8728. What classes of children have chiefly been educated there?—I should think the children of the better mechanics and of the smaller shopkeepers, some who thought they would get more of what they wanted there than elsewhere, and many came from a considerable distance.

8729. At what age are they admitted?—I think they are admitted as young as 6, generally speaking; I suppose they remain till they are 13 or 14, perhaps some stay a little longer.

8730. Can you give us any description of the system of education adopted at the Birkbeck School, and any distinguishing characteristics of it?—The only distinguishing characteristic, as far as I have had any hand in it, is, trying to teach what, for want of a better name, I have called elementary social science. Latterly I have rather wished to call it instruction in the rules and conduct of industrial life, so as to strip it from an appearance of an assumption of doing anything very great in a scientific way.

8731. Can you give us any description of the plans that you adopted with a view to the teaching of this branch of instruction?—I was induced to assist in establishing the Birkbeck School, because I could not prevail upon the people over whom I had much influence to introduce this subject into common schools. Many years back I began teaching to a class in a British and Foreign School myself, and then I taught in the Birkbeck School. It is very difficult to give a notion of the whole of the method of teaching, and, perhaps, if I were to begin from the beginning it might fatigue the Commission; but my method with a child is this: I say that we want to dismiss him from school with



the capacity of self-guidance, an object I suppose only common to me with everybody else who has thought much upon education; but the difference between me and other people who have interested themselves in schools is, in the view which I take of the character of the ignorance to be guarded against, and of the instruction which ought to be given for that purpose. Take all the discussions that are going on between masters and servants, between employers and employed, between, as I may call them, capitalists and labourers, I believe that all those difficulties are mainly attributable to ignorance in the beginning, and I have fancied, from a long study of the subject myself and 20 years' teaching, that it is exceedingly simple, when once there is a teacher competent to teach; for the children can readily take it for themselves—my plan of teaching being as nearly as possible to tell the children nothing but to make them tell me everything. At the beginning, I would say to young children even, "You know what you are doing every day of your lives, the food you are eating, the clothes you are wearing, the house you are living in, and the furniture that makes it pleasant and comfortable to you; and when you go into the streets you see the pavements, the pipes for supplying us with water and for supplying us with gas. Think of what is going on all round you. Where did all these things come from? Did they come of themselves?" The children say, "No, our fathers and forefathers worked for them; and having worked for them, they say to themselves, they have preserved them to our time, and we are born in the midst of them." "What are you doing with them?" "Consuming them—wearing them out." I make them see the distinction between the food which they are eating, which disappears, and the clothes which they wear out, which disappear gradually, and I leave them to the thought that everything which they see around them, that has been produced by labour, and has been saved for them, is being consumed either quickly or slowly. I let them see the distinctions between the food that they eat and our great monuments, Westminster Abbey, for instance, and others, all gradually and slowly wearing out, if men do not take the trouble to repair them, and, where necessary, replace them; and I ask, "What would happen to us if all this were not done?" The children say simply enough, "We should perish in the future as surely as we should perish now if all those things were suddenly destroyed." Then while we are consuming them what must we do? Replace them, repair them, keep them in order; and in order to do that, what kind of people must we be? and they find out for themselves that we must work, and must work intelligently and skilfully; we must save. When must people begin to have those qualities? when must they begin to be industrious, to be skilful, and to be intelligent? How are they to be intelligent, if they do not learn? With a skilled teacher, with a teacher who puts feeling into his teaching that serves to interest the children, I believe a very clear conception may be gained by the children, and a very deep impression made upon them, of what they have to do while they are in school to qualify themselves to be the right kind of men when they go out to replace all these things; and if they do not replace them, misery will be the consequence. Then I draw their attention to the fact that they are not living as isolated individuals, but that they have to live as members of society; that if they wish to be happy they must live in harmony with others, and must have the good feeling of others, as well as impart to others their good feeling towards them. That is also to be cultivated, and to be cultivated in something besides words,—to be cultivated in actions to show that your good feeling is to go beyond mere expressions. You must be industrious, skilful, intelligent, and saving, in order to be able to indulge in the pleasure of foregoing an enjoyment of your own, and to impart a share in it to others. The next step will be to give them a still stronger feeling of the necessity of saving. I put to them, "How many harvests have we in England?"—"One." "How many days' food

"do we want out of a single harvest?"—"365." "How many meals a day do you like to have?"—"Three." "How many meals would that make a year?"—"1,095." "How are people to get 1,095 meals out of one harvest?"—"By saving." And all this is well followed up by the children's illustrations, which we bring out from the children themselves, and illustrate from the mother's cupboard—what she puts by after the meal is taken, so that they could see for themselves, without my telling them, that economy is absolutely necessary to enable people to live comfortably. More than this, "Are the harvests always so good as to replace everything that we consume during the year?"—"No." "How are we to save ourselves from starvation or semi-starvation if the harvest is very late and very bad?"—"By saving from the previous harvest." The children will then tell me the importance of directing our attention to produce such articles as corn instead of spending all our labour upon potatoes, because corn can be preserved over from a good harvest to a bad harvest, and for years if necessary, whereas potatoes can only be preserved for a single harvest. Another reason: people are subject to ill-health, and certainly if they live to an old age people cannot work so well, and how are they to live then? When you are struck down with illness, which we all of us must expect in the course of our lives, while you are tenderly nursed by your friends when lying on a bed of sickness, you will have to consider, while you are so indebted to them, whether you are living upon your own resources or the previous savings that you have made, and are able to furnish something so as not to draw too much upon their affection, or whether you are actually obliged to them for their charity. There is no difficulty in these matters, for children can perfectly understand all such things if presented to them by a teacher really competent to interest and instruct them.

8732. (*Professor Huxley*.) Will you tell us at what age you think that such teaching as this might commence?—I see no reason, in the most elementary part, why the children in an infant school might not have some of it. For instance, in my little book, which is the result of my labours with the children, called *Progressive Lessons*, I begin with, "Why do people dig, and why do they plough?" and I occupy the whole of the first time with similar questions and talk arising out of them. There is nothing profound, and there is nothing far-fetched, in all that—nothing but what a child would listen to with interest. Of course, a child is liable to be bored, and we must take care to avoid that. I take it that, in the wish to give scientific education to children, the object is really to improve society, and, as part of the improvement of society, I wish more particularly to see the population (without saying how much more I could wish for them) supplied with food, clothing, fuel, and decent shelter. When we are horrified, as we are, by seeing that six families are living in six different rooms in one house, and sometimes seven or eight individuals in one room, and we see many other instances in society around us of so deplorable a state of things, I take it that the object of us all is to see our way how we can improve society through education. What is commonly called the scientific part of education, omitting that part which I am dwelling upon, is to give children, I suppose, a certain command over the various powers of nature; and it is my wish that those who go into the workshops, and those who go into the banks and counting-houses, and the farms, in addition to all the attainments that they may have in this way, should have a clear perception of what kind of a world it is they are working in, and with all its disadvantages, what is the best they can do both to improve themselves and to improve others. That is my general notion. It conveys very little in general terms, because people might say we are all aiming at the same thing. I have given the fundamental notion which I consider children may learn, of the necessity of industry, skill, intelligence, sobriety, and economy, and when they must begin to get those qualities and

W. Ellis, Esq.  
19 May 1871.



W. Ellis, Esq.

19 May 1871.

what they must do. For instance, when an ignorant man comes before us suffering, we pity him; but when you, as a boy, have got clearly to understand what mischievous agents ignorant people are, with the want of those other qualifications, if I do not find that you are striving to learn, to back your father's efforts or your teacher's efforts who are trying to teach you, then I say, "If you will not try to learn under them I do not see how I can make you an object of my pity merely. You make yourself an object of my aversion. I think you are a bad boy for not exerting yourself to learn and acquire good habits. There is no such reason for pitying you as there is for pitying a poor old man who has been neglected in his early life." And I believe the children all feel that. I think it is of immense importance, as part of their school training, that they should have that feeling. Now I say to boys, "When you leave school how are you going to live?"—"Work for it." "Yes," I say, "and does work take away appetite or give an appetite?" and they soon find out that it gives it. Then I say, "You want some share of all those things that are around you." I make them understand what the meaning is of selling their labour when they are cast off from their parents, as some will be at the age of 13, 14, 15 and 16, some partly and some wholly, and have to depend upon themselves. "You have got to sell your labour." "To whom?" "Who will buy it?" "What recommendation must you go with to him?" "You want him to bestow upon you some of the property which he has got, and he says I want it for the future." "Your argument to him then is, let me have this to-day which you only want in the future, and my labour shall replace it, and something more, in the future when you want it." That is an advantageous bargain for both parties, and when we go on a step further and ask them whether it is a good thing that there should be persons in the world with this wealth that they are ready to part with, and ready to give them direction in using it, they can have no doubt about it. Then I say, "That man is called a capitalist, and he is willing to give you a share of his capital. Is he a blessing to you or a curse? Is he an oppressor or a saviour? What would you be on leaving school if there were not somebody ready prepared to do this?" Thus all the relations between the capitalist and the labourer are unfolded to the child. I merely give a new name, and when the same thought is presented by the new name, the thought remains the same: "What kind of wages do you expect when you leave school?"—"Small. Why?—Because my labour is not worth much; it cannot produce much. May you for six months, or even a year, be an incumbrance to your master? What ought you to do then when you have got an introduction to him, and he has taken you into his service?—Work as hard as I possibly can to please him, to make myself useful. Ah, that is for him; doing that is not of much use for yourself, is it?—Yes, it is, sir. Supposing you acted differently, would that be the way to improve your habits of industry, to improve your conscientiousness, to improve your skill, and to show your readiness to learn if there were others with more experience than yourself willing to teach you." Then I think it is a very desirable thing that it should be unfolded to children, that as this world is constituted, there must be 20, or perhaps 50 workers under others; 20 or 50 employed for one employer, and that this one employer, who has developed in the course of time, himself starts among the employed, and he rises out of the number of 50 or 20, whatever it may be, according to the aggregate of his qualifications. There are examples without number in the world, quite within the understanding of a child, to bear that out. You say there is the necessity of obedience; there is the necessity of discipline; there is the necessity of acting in numbers, and always understanding that, when you have sold your services to another, your duty is to make yourself as useful as you can, not only for his sake, but for your own. We have then got hold of the term wages; "Your wages are small? How may you hope to secure a comfortable

existence all your life by means of your wages; what are you going to do with your wages?—Use them partly to live upon and partly to provide for the future." That introduces the subject of saving. "If you make savings as you ought, the illustrations of that again may be numerous." Boys may say, "We must give all our savings to our parents." When I was teaching in one of the poorest schools in London, I said, "Perhaps you will earn only 6s. a week, and I put the thought into the boy's head that he might persuade his father and mother, with the benefit of the instruction that he had got, to put by a penny only. I do not mean to say that 6s. will be too much to give your parents, and that you will not do a very wise thing to consult them and place it into their hands, but if you were to talk to them in this way: 'What will be the effect of your putting by a penny a week only; at the end of the year 4s. 4d., and at the end of two years, if your wages did not rise, 8s. 8d. And what will you have gained besides?' What will be the influence of this kind of conversation upon your younger brothers who are still at school? What effect will it have upon your command of temper and your willingness to make yourself useful, to do other people's work in case of illness or any emergency arising, and being punctual and keeping command of your temper? Then, when we have got the savings, what is to be done with the savings? Put them into a bank; what do you mean by putting money into a bank?" That leads them to the thought that saving really means lending; saving ultimately to be employed by others who can earn a profit and give them something. Then I draw their attention to 2½ per cent. which is given by the Post Office saving banks, and ask why the Government have established Post Office savings banks, and what their object has been? They tell me that it is to encourage habits of saving and to give a place of safety for deposit. "Why do not the savings banks give more than 2½ per cent., if they wish to encourage habits of saving?" "Because they cannot afford it without taxing others." Then, say that you take up an advertisement in the newspapers, where a grand sounding company will tell you that they will take deposits and give you 6 per cent. "Tell me what you know of those people; I will not name them; tell me if you know them by that alone." Then the chance is that they will say what may not be very complimentary either to the intelligence or to the morals of the advertizers, but they themselves will not trust their savings to such people; and they get the idea of interest and they get the idea of profit. "Is a capitalist who is employing labourers and earns a large profit the best friend to the employed or the worst friend?" They get no idea that the large profits of capitalists come out of the sinews and nerves and health of the labourers; that it is, as some of the French Communists say, l'exploitation de l'homme par l'homme, but that the capitalist is a great benefactor. He need not be a good man, or a better man than the employed, but as a capitalist he is a benefactor; that the more successful he is as an employer the better friend he is not only to the world but to all whose labour has been directed by him. Next to that we come on to the division of labour. The division of labour introduces, of course, exchanges and the use of money—the term money hiding, as it so often does to the ignorant, what the reality is—the money's worth. The advantage of buying and selling, and the advantage of perfect freedom in that respect are recognized without difficulty, abroad as well as at home, and as included among them the advantage of perfect freedom of commerce. Not, mind, that I would recommend either myself or anybody else to tell those things to children; the children with anything like skilful teaching will tell us those things themselves. Then we introduce the uses of money, which are not always very clearly understood even in the City, nor always even in our Houses of Legislature. A little special instruction from the teacher is needful to explain to children our weights and measures, and our money. With that exception, I believe that all the other matters, the



taxation which is necessary, and the protection of the Government that is to be paid for, I believe all those are matters which, with skilled teaching, children will see for themselves, and tell their teachers; and when, in the course of instruction, the child says what is wrong, the business of a skilled teacher is to put other questions which will make the child put himself right. I believe, in a general way, that is about the kind of thing that I am attempting to teach.

8733. (*Chairman.*) This system must apparently require a large amount of skill on the part of the teachers; have you had much difficulty in obtaining teachers capable of imparting such instruction?—Independently of the first Birkbeck School, which is not one of my own, the four schools that I have established have all got masters who teach it, and with the exception of one, they have, perhaps, all received their instruction from me; but the principal teacher is a gentleman of the name of Shields, who is an exceedingly remarkable man, and very well known to all who take an interest in education, and if an example were wanted of how the thing could be done, I believe there is nobody more capable of giving it than himself. I do not profess myself to be a teacher. I am only an amateur out of business hours.

8734. Still you trained the teachers. You were the fountain head of the system of teaching?—I set the thing going.

8735. What amount of success has attended this system, so far as you have been able to ascertain?—That is a very difficult question to answer. I have not heard of any children from those schools having been in the poor house. I do not know that any of them have been before the criminal courts, and I do not know that any of them have figured in the Bankruptcy List; but many of them individually I know have got into very good situations. This kind of instruction would have, and, perhaps, could have, no other success than that of enabling people to take care of themselves and become useful members of society, whatever line of life they went into.

8736. Do you think that they have been able to take care of themselves better than others who have had the more ordinary kind of teaching?—I do not see how it could be possible that they should not. We have got many illustrations in the world of the progress of knowledge on perfectly familiar things that were hidden a few hundred years ago, and we cannot help seeing that when those things are taught they really are understood. There certainly are very few children in the world who do not understand that we are living on the outside of a globe, but there is nothing in all that I am attempting to teach in the schools that is at all more difficult, if it is quite as difficult as, to make clear to young people that we are living on the outside of a globe. The subject which I have taken in hand is involved in mystery to many, but the matter may be treated from the simplest illustrations and elements, so as to be made intelligible to all.

8737. I think we may understand that in those schools there is not much of regular systematic teaching in any branches of physical science, as it is commonly understood?—I believe that is all taught in those schools.

8738. I rather understood from you that it was more by way of questioning the children?—No, this is something in addition.

8739. Can you tell us what is done in the way of teaching physical science in those Birkbeck schools?—Elementary chemistry is taught there, and elementary physiology. There is one young man who has gone up to Oxford from the Peckham Birkbeck School. He was very ambitious of doing something better for himself. He had been under Mr. Shields from a child, and when he went to Oxford, with the knowledge of chemistry that he had got, Sir Benjamin Brodie expressed his astonishment, and asked, "Where did you get all this chemistry from?" He was quite surprised that he should have got it from such a school, but that is only one example.

8740. You find no difficulty in allotting sufficient time for instruction in chemistry and physiology?—No.

8741. Do you know at what age instruction in those subjects begins?—I should think they would begin with it at nine years of age. Mr. Shields' chemistry is all taught by simple illustrations, and with the use of a black board.

8742. (*Professor Huxley.*) I think I understood that you were on one occasion asked to give some lectures upon the subject of teaching social science at one of our training colleges?—Yes. In the year 1859 I gave six lectures at the South Kensington Museum, and I was teaching in Mr. Rogers' school besides in the daytime once a week, at St. Thomas's, Charterhouse, and the training master at St. Mark's College, Mr. Dayman, attended one of my lectures and expressed himself to be deeply impressed with it; and he came down to St. Thomas's, Charterhouse, one morning, when I was teaching there, to attend the lesson that I was giving to the boys; and when it was done he asked me if I would come and give some lectures to the young men in the training college. I suggested to him that it would be a much better plan, for I do not profess to be a lecturer, if he would get me a class of his boys from the trial school for an hour, which would be more convenient for all parties, and I would come and give a lesson to those boys in the presence of the young men, so that they might see how the thing was done. I gave, I think, a dozen lessons, and when those dozen lessons were finished, he again came to me and said, "Make the last four lectures to the young men." I said, "Very well, if you wish it, I will do so." I went on with the subject from where I had left off with the boys, and when I had finished, Mr. Coleridge, who was then the head of the Training College, when I was going away, turned round to the young men and said, "I am sure you would not like me to allow Mr. Ellis to depart without trying to thank him in your name for what he has done," and he paid me some compliments, which I need not repeat, and I went away. He deeply impressed upon the young men the importance of this teaching, but from that day to this, as far as I can learn, the subject has never been breathed in that school. That is an instance of what you may call passive resistance; the same kind of passive resistance that caused Adam Smith's work to lie fallow for a long time, till Richard Cobden and some others took it up.

8743. Are you acquainted with the science examination of the Science and Art Department?—Very little.

8744. But I presume you know the general nature of that examination?—Yes.

8745. Would you think it desirable to introduce an examination upon subjects of social science among the other examinations of the department?—It could not do any harm certainly, but I take it that it is a little different from all the other branches of science. It strikes me that it is a putting together of the results of all the others, and we then ask a young man who has got all those attainments, what use he is going to make of them in the world? I think we see the same thing on board a ship. When a ship is lost, there is a Commission of Inquiry into the loss of the ship. The master may have all the attainments that are requisite, but he has omitted to take soundings where he ought to have done so; he has omitted to do this, or that, or the other thing, which condemns him and causes his certificate to be suspended. With regard to boys who go out into the world, let them have all the scientific attainments you please, but is it not possible that with those scientific attainments there will be a great want of what may be called common sense, or good sense, or judgment, if you like?

8746. Do you propose to get that into boys by any system of examination?—Scarcely, and that is the reason why I limited myself to saying it could not do any harm; but an examination in the common sense of life, or, as I would call it, the capacity of self-guidance, I should consider like an examination in religion; I do not think I should give a great deal for it, but it would not do any harm.

W. Ellis, Esq.

19 May 1871.



W. Ellis, Esq.

19 May 1871.

8747. But how could you test the efficiency of the teaching, except by an examination of some sort or another?—There is the difficulty.

8748. Do we understand that you are a little doubtful as to what would be the value of introducing examinations, like those in branches of physical science, into such a subject as social science?—I simply say that it could not do any harm.

8749. That is merely a negative phrase?—Yes, it is. If a lad were coming to me in the City to take a post in an office over which I had any control, I should look to see that he had got a good knowledge of figures, and that he knew a certain number of other matters, and was able to write a letter that was dictated to him. I should say to him, "Now what are your thoughts with regard to yourself? You are coming in here at 60*l.* a year to begin with; what are your thoughts about this 60*l.*?" That would be the kind of question I should put, and then later in life I should like to know what he had done. I should say to a boy in one of our schools, "Now, when you are answering me in this way, suppose I were to go away, and, ten years hence, if I live long enough, were to come back and see you, and I find that you had no capital, tell me what I should know of you besides? I should know that either you had not been industrious and intelligent and painstaking, or if you had been all that you had not been economical. I should not wish to be hard upon you, because I see that there might be an excuse for it; that nobody could deny for a moment." You might say, "I lost my father early in life, I am the eldest child, and I have a mother and younger brothers and sisters, and I have given my savings to them;" that would be an exceptional case, but if it were not an exceptional case like that, I should say, "You have got a want of being able, in your conduct, to think of the future as well as the present,—the most fatal defect I believe that a young person can start in life with." Very frequently, both in the City and among the poorer classes, you will find people not only living upon the whole of their wages, but actually spending the wages that are coming in; another way of getting into debt. I try to raise up a feeling in the child of the ignominy and disgrace and wickedness of incurring debt, and then I explain to him the difference between a person who is indebted to another, as a banker is to his customers for the purposes of production, and borrowing for the purpose of spending.

8750. I understand that you have no question about the importance of having these things taught to children?—I have given the best evidence of that.

8751. You quite understand, that, if such subjects were to be introduced into elementary schools, it would be necessary, in some way or other, to test how they were taught; can you suggest any means better than examination?—I have often said that the first and essential thing is to have teachers qualified to teach such subjects, and, in the absence of them, or in the very great scarcity of them, I would have efforts made to rear them up. We ought to have this kind of instruction given in our training schools; I do not see any substitute for that, but the next best makeshift is, that Her Majesty's Inspectors should be themselves capable of understanding all this, and competent to take a bird's eye view of every school and go into it, and see whether there was general instruction and discipline of this kind; but my experience of inspection for that purpose is not very favourable. I have had some of Her Majesty's Inspectors attending my lessons, and I have talked to them, and they have generally acknowledged it to be the great want of the time, and I have heard many of them say, that, if they could have their own way, there ought to be no school without it, but when I have read their Reports to the Privy Council, I have not seen the subject mentioned; there is passive resistance again.

8752. (*Chairman.*) Have any other schools been founded on the same system in imitation of yours?—I cannot say that I know of any. I believe there are some schools in which the same matters are taught,

but I do not pretend to have any different system in these schools, excepting the introducing of this one thing in addition; it strikes me that it is something which is unworthy of our age that we should have schools, and that the boys should leave the schools totally ignorant of the nature of the world that they are going into, and the kind of conduct that they have to pursue in it.

8753. (*Sir J. P. Kay-Shuttleworth.*) Probably you would think that the best mode of introducing such a system of instruction as that which you have been so successful in developing in the Birkbeck Schools, would be, that in the training colleges there should be some master or professor who had both the knowledge and the skill, and who would, not simply by lectures, but by the constant exhibition of the mode of teaching in a practising school, give to the young men in training skill in the method which you have yourself pursued with so much success?—That is exactly what I should say, only wishing to modify the complimentary expressions that you have made use of as to my having done it with so much success. The success that I have attempted to get I am willing to admit, but I believe that I have done nothing compared with what may be done by properly trained persons. And one other little alteration I would make, if you will allow me, that it should not be the Professor simply who should do this but the Principal of the school.

8754. Supposing that the Principal of the school had not the requisite skill, because not knowledge simply is required for this kind of instruction, but a peculiar skill in the mode of communicating that knowledge to very young persons and adapting it to their intelligence, and developing their power of thinking on these subjects; supposing, I say, that the Principal had not that knowledge, you would not object that some principal officer of the college should himself be charged with that duty?—Certainly not. My plan always in this world is, if I cannot get the best out of it, to take up with the next best, never forgetting, however, that it is but the next best; and if the next best be doing the work, I would insist that he should have the fullest confidence and the strongest backing in every possible way, so that all in the establishment should feel that the Principal was thoroughly in earnest himself; that, of course, would give a great tone to the whole character of the teaching.

8755. What I understand from your answer to Professor Huxley, as to the great difficulty of introducing such subjects in examination papers, is, that you would desire to divest the subject of the purely technical form and to introduce it in that form which would be most interesting to the minds and most capable of developing the intelligence of the children, and, consequently, that you would exceedingly deprecate that merely political economy should be learnt by the students of the training college, or that merely social science in a technical form should be learnt by them; but what you would desire would be that they should acquire the power of interesting children in the best methods of self-guidance in life?—That is exactly my sentiment, only better expressed than I could do it. When I was lecturing at the South Kensington Museum, as far back as the year 1859, I said to the teachers who were present, "These lectures of mine are called lectures in elementary social science, and the first thing I beg you to remark is, that in teaching you should drop the name at the door before you enter the building," which is another mode of expressing how entirely I coincide with what you have said.

8756. (*Chairman.*) Are any books or manuals made use of by the teachers in giving instruction in social science?—Mr. Shields uses a book, and, as it is not a very large one, I did think that I might be pardoned, in spite of its being my own, for bringing it here; it is very small, but it will give a very good idea of the system. Mr. Shields teaches from that book; there are a hundred lessons in it, and the proposition at the head of each is written on the black board, and then the



lesson goes on. The questions that follow are all suggestive questions, with no answers to them, because I

The witness withdrew.

6, Lancaster Terrace, Regent's Park, North,  
May 29, 1871.

SIR, IN returning the proofs of my evidence, I cannot refrain from confessing to you how deeply dissatisfied I am with myself. In that state of mind I left the Commissioners, and it has been confirmed by the perusal of my evidence as reported. I hope, therefore, you will endeavour, if only from compassion, to bring before the Commissioners the few remarks which I wish to have appended to what is now in print.

I was asked, as you know, "to give evidence on scientific instruction in elementary schools," and I ought to have excused myself from wasting the time of the Commissioners on the ground of my incompetency, or else I ought to have done more justice to the subject which has for a quarter of a century occupied much of my attention.

If I have any justification for thinking of myself in connexion with science, it must be with science in its bearing upon conduct as between individuals and society.

Science, as generally understood, occupies itself with the structure of the physical world, and the forces comprised in it, leading to the capacity in men of dealing with those forces, and accommodating themselves to them.

Scientific instruction in elementary schools would, I conceive, scarcely interest thoughtful and benevolent men as it does, did they not hope, through its influence, to promote well-being, or, more humbly, to abate the frightful prevalence of destitution, vice, and misery in the midst of which we dwell.

The scientific instruction which I wish to see introduced, and which I have been endeavouring to introduce, into elementary schools, is to supplement all other scientific instruction so as to make it more effective in promoting well-being.

The deliberations of the Commissioners, the labours of the various boards of education, and the legislation upon which they are based and to which they may lead, all point to the assumption that well-being, individual and national, rests upon conduct; and the practice of conduct presupposes a science of conduct.

It is instruction in this science of conduct which I think ought to proceed *pari passu* with all other instruction. It is that which teaches how to apply other knowledge so as to lead to the general well-being, of which each is to receive his share. It is that which imparts a knowledge of the essentials of good self-

abominate the system of cramming in everything, and if in everything, particularly in this one thing.

guidance, and induces thoughts of self-discipline as a necessary preparation for nobility of character and goodness of conduct, or self-guidance.

There are many, I am aware, who doubt whether instruction in science can be imparted in elementary schools. Such doubts, of course, originate in misconceptions concerning the nature of what is meant by "science." But of all sciences, the least difficult to learn, provided there were but competent teachers, is the science of conduct—the science which directly unfolds the rules of self-guidance, and indirectly inspires thoughts and aspirations conducive to good self-discipline, the only reliable source of subsequent good conduct.

Our training schools ought to form such teachers. School-Inspectors ought, above all things, to observe and report to what extent knowledge of the rules of conduct, which lead towards well-being or guard against destitution, pervades a school, in company with discipline likely to insure good conduct. And the President of the Privy Council, or the future Minister of Education, himself inspired with thoughts of education as a chief means of extricating society from the slough in which it is immersed, ought to urge upon the Principals of training colleges, Inspectors, and Teachers such a performance of their respective duties as to make manifest to the public that education is capable of doing vastly more than it has done thus far for the benefit of mankind.

It is difficult to decide which is the more distressing to a thoughtful observer, the normal suffering which we have always present among the destitute and poverty-stricken, or the abnormal, of which part of Ireland, our large towns, and Sheffield in particular, and, lastly, Paris, afford such frightful examples.

But all this suffering, normal and abnormal, seems to me to arise less from want of knowledge of physical science than from want of capacity to turn to account the resources which physical science has placed at man's disposal. While, therefore, heartily concurring in the desirableness of extending instruction in physical science in our elementary schools, I think it would be a fatal mistake to sever it from instruction in that science which will assure its being used for good purposes.

I am, &c.

J. Norman Lockyer, Esq., Secretary of Aid to Science Commission. WILLIAM ELLIS.

The Very Rev. WILLIAM CHARLES LAKE, D.D., Dean of Durham, examined.

8757. (*Chairman.*) Measures are now in progress having for their object the establishment of a College for Physical Science at Newcastle; will you be so good as to describe to the Commission the causes which have led to those measures being taken?—When I first came to Durham, I found that there was this great defect in the University, that it did not seem completely to meet the educational wants of the North, and it was very difficult to know how entirely to remedy this defect, because it is evident that, from circumstances having much altered since the first foundation of the University, from the much greater facilities of communication, and also from the very large number of scholarships and exhibitions which, at the two older Universities, have been thrown entirely open within the last 15 or 20 years, young men are more drawn to those Universities and have greater facilities for going there than they had before, and, therefore, the original reason which had led to the foundation of that University at Durham, namely, that it would draw the large bulk of the people of the North country, has ceased to be so cogent as it was at first; in fact, has almost entirely ceased to exist. It, therefore, naturally was my wish, when I went to

Durham, to make the University, of which, as you know, I am *ex-officio* Warden, more useful generally for the education of the North; and, on examining the subject, I could not find any better means of doing that than by endeavouring to establish, in connexion with the University, a School of Physical Science. Then the question immediately arose, Where would be the proper place to found this school of physical science? Should its position be at Durham, which would at first seem the most natural place on many accounts, or should it be placed at Newcastle? Opinions were to some extent divided upon that point about 10 years ago, at the time when the Commission for the University of Durham was sitting, and strong evidence was given by Mr. Nicholas Wood in favour of Durham; on the other hand, very strong evidence, and, in my opinion, more conclusive, was given by Mr. Lowthian Bell in favour of Newcastle; and, having very carefully weighed the matter, and having, I confess, been at first inclined in favour of Durham, on account of the obvious advantages presented by an University town for that purpose, and especially on account of the pecuniary assistance which we should possess by having lecture

W. Ellis, Esq.

19 May 1871.

Very Rev. W.  
C. Lake, D.D.



Very Rev. W.  
C. Lake, D.D.

19 May 1871

rooms ready, I, nevertheless, at last, came to the conclusion that to establish a school in Durham, which would do part of its work at Newcastle by its Professors going there to lecture, would be a failure. I thought that there would be difficulties in working such a plan, and also I was very much influenced by the fact, that almost all the eminent employers of labour whom I knew in that part of the country, and who are most interested in the subject, were very strongly in favour of Newcastle, on a variety of grounds, which I will not at this moment enter into. The University, therefore, took means for ascertaining whether, in accordance with our charter, we could assist a school at Newcastle. We took the highest legal opinion on that point, and we found that we had power to assist a school at Newcastle, although I somewhat doubted whether that power would allow us to apply a very large portion of our funds for that purpose. However, we went as far as we could, at present, in proposing, at a public meeting at Newcastle, to give 1,000*l.* a year to an institution of this kind, supposing it could be met by a corresponding donation of 30,000*l.* The original proposal I should say, to be accurate, was of a more tentative character. We proposed, at first, to try the experiment of a college of this kind for five years, subscribing 1,000*l.* a year, and if they would meet that with a subscription of 1,000*l.* a year, we thought that then when the College was seen to be able to work, people would be willing to assist it; but we found that the response was extremely liberal, and, at our first public meeting, more than the required sum was collected in the room, and we were, therefore, emboldened, in the course of a week, to ask for a sum of 30,000*l.* We determined, at first, to make what collections we could privately, and after we had obtained a certain sum then to go to the public for the rest. A sum of about 15,000*l.* or 16,000*l.* was subscribed in the course of a fortnight, and within the last week or ten days we have now placed our propositions for the establishment of the school before the public.

8758. The public has not yet offered the 30,000*l.* required?—Not yet; but then it has only been appealed to for the last fortnight or three weeks.

8759. Is it your opinion that 60,000*l.*, 30,000*l.* contributed by the University and 30,000*l.* by the public, will be sufficient to start the project?—Only to start the project. I think that even to start the project it is barely sufficient, when you consider that we cannot do this with less than four Professors, even limiting ourselves at first to the establishment of a simply Physical Science College, and such limitation in many points may not be desirable. When you remember this, it is certainly the very least with which we can start, to begin with 60,000*l.* We only do so in the hope that by making a vigorous start, and showing that we wish to make an honest attempt, we may afterwards, from different sources, obtain more, especially with a view to buildings. It is obvious that we cannot erect any buildings out of the sums with which we now start; and what we propose to do now is, to use some buildings which happily are very well situated for our purpose, paying for them a rent of 250*l.* a year.

8760. A certain amount of apparatus will probably be necessary?—In that respect, to a great extent, we are helped by there being various Philosophical Societies, and especially a Medical College at Newcastle, which will assist us at first.

8761. Is it proposed that the 2,000*l.* should be chiefly employed in the payment of professors?—The manner in which we propose to employ the 2,000*l.* is pretty much this, 1,600*l.* for the payment of four Professors, including two skilled Assistants. Then a Secretary will require at least from 150*l.* to 200*l.*, and 250*l.* more go for our buildings, and, as you know, there are a great many et ceteras connected with the use of buildings, so that we have already got beyond our 2,000*l.*

8762. Do a great part of the large employers of labour in the counties of Durham and Northumberland look with favour upon the proposed College?—A very

large part, I think. There is a strong feeling in favour of a scientific college at Newcastle. There has been a great deal of talk, and, to some extent, a difference of opinion on the subject for the last 20 or 30 years. I believe it is a subject which has been constantly discussed, and the various claims of Durham and Newcastle have been very much debated, and, certainly, there has been a good deal of difference of opinion on such grounds as I have mentioned. For example, about 20 years ago the Duke of Northumberland offered a sum of 5,000*l.*, supposing 10,000*l.* were raised otherwise, and 10,000*l.*, supposing 20,000*l.* or 30,000*l.* were raised otherwise; but that met with very little response, indeed; I imagine, in consequence of the proposal having been to place a physical science school at Durham. But at present I must say, with few exceptions, so far as I know, the great employers of labour have all of them responded to the proposed plan, and most of them (as, of course, Sir William Armstrong, who, if he is interested in anything, always supports it heartily,) have responded very liberally.

8763. The idea of any part of the instruction being given by professors from Durham, we understand you to say, has been abandoned as impracticable?—Yes, by any of the professors living at Durham. For our own school at Durham, where we do not anticipate a large number of students of physical science, from difficulties which I may perhaps have to go into presently, we think that a course of lectures from time to time, given by the professors who are now to be established at Newcastle, will be sufficient.

8764. At what age do you contemplate that the students will enter this college, or will begin to attend the lectures?—I contemplate all varieties of students. I think that the persons whom we may naturally hope to have will be young men of fair position who are wishing to occupy higher posts in the mining profession, wishing, perhaps, to become what are called mining engineers, and that they will probably, at the age of 16 or 17, find it worth their while to come for two years.

8765. Do you contemplate having any preliminary examination to ascertain whether their previous education has been sufficient to render them competent to receive sufficient advantage from the courses of lectures?—We have not gone sufficiently into the details to go into that point, but I think it will probably be necessary.

8766. What are the professorships that you would propose to establish?—The first is a professorship of pure and applied mathematics, as being the foundation of all our work; next, one of chemistry; thirdly, experimental philosophy; and, fourthly, mineralogy and geology.

8767. In pure and applied mathematics, should you contemplate that they would not come quite uninstructed in that branch of knowledge?—Certainly, or they would be unable to profit by the lectures.

8768. The lectures would be of a somewhat advanced description?—Yes.

8769. Have you considered what portion of the amount which would possibly be raised by fees should be appropriated to the professors?—We have been guided a good deal by the example of Owens College, Manchester. We have thought that two-thirds of the fees should be given to the professors.

8770. Are you able to name what would be the amount of the fee for the course of lectures?—I think 15*l.* or 16*l.*

8771. Would that be for the whole year?—Yes, for the whole year, for all the courses of those four professors.

8772. The students, at their choice, would attend one or more of those courses, but would they all pay the same amount?—No. My idea would be, that for a single course the fee would be 4*l.* or 5*l.*, I forget which, but that sum of 15*l.* or 16*l.* would cover the whole. I should not like to say that it might not be raised, supposing we could do so safely, but that is what we thought it most desirable to start with.



8773. Do you contemplate making any application to Government for assistance?—Yes, I contemplate that, but whether there is a great chance of our succeeding must, I think, depend upon your contemplating it also.

8774. Do you think it would be impossible to put the proposed college on a satisfactory footing, financially, without assistance from the State?—I certainly think that, at all events, for a given length of time, when we have got 30,000*l.*, we shall have reached the end of our tether; we shall have got as much as we can from the public, and although I have hopes that we may be able, at Durham, to assist them still more, yet our funds are very limited, and I do not see that, within the next two or three years, having now appropriated 1,000*l.* a year, we could with justice appropriate more than 1,500*l.* Therefore, that would give you the sum of our expectations, and I do not think that that is enough, unless we have a very large influx of pupils, to carry on the College as one might wish it to be carried on, especially as I do not think it is desirable that it should continue always simply a Physical Science College. I should like to add such parts of a more general instruction as would give the young men going there a tolerably complete education. I should be very glad to add a professorship in French or German, and again a professorship in the English language and English history, so as to make it a tolerably complete modern education, otherwise I think that we shall lose a great many pupils from the sons of tradesmen in the town, saying, "Oh, but we only get one half of our education at this college, and there is no other place to go to for the rest;" so that, on those grounds, I should like to make it ultimately pretty much what Owens College is at Manchester.

8775. A place of general education, but having especial reference to the physical sciences?—Yes, exactly.

8776. If the experiment should promise to be successful after a few years' trial, the University would probably be willing to appropriate 500*l.* a year, in addition, towards its support?—I hope this might be the case, but I think that it would not be right in the University to appropriate it until things look a little certain.

8777. Is there any provision made at present at Durham for instruction in physical science at the University?—There is a course of lectures delivered every term by a competent lecturer, who lives at Newcastle, and comes over and gives courses of lectures, and there has been, till lately, a course of lectures in engineering, but no students came to the engineering course, and, therefore, it dropped.

8778. To what causes do you attribute the absence of students for the engineering course?—I think that the great bulk of the young men live in Newcastle, or round Newcastle, and they have to come from some distance to Durham; they do not live many of them actually in Durham, and, therefore, you get very few, and I think the mere fact of a very few coming is a discouragement to the lecturers.

8779. But is the other course of lectures that you previously mentioned better attended?—That is attended by the young men who are at Durham for the purpose of a liberal education, who go in for it just as young men in a similar position might at Oxford, but it does not draw young men to Durham for the special purpose of getting a scientific education.

8780. What arrangements do you propose with respect to examinations?—We propose an examination at the end of the first year. I should say, in mentioning this, that we have not yet gone into those points of detail, because, as you are aware, the thing has not been broached long, but I may say, generally, that we should have an examination at the end of the first year, which, of itself, might be a certain testamur to a young man of his having passed the physical science little-go. Then we should propose to give a final examination in physical science at the end of the second year, which would entitle him to some University title of distinction, such as Associate in Science,

though not to a B.A. degree. We should require for that, I think, the addition of some literary qualifications.

8781. The examinations will entail a certain amount of additional expense, will they not?—Yes, certainly. The examinations, according to our idea of the plan, would play a very important part. We think we might give distinction to those young men, by having a strong board of examiners, and, therefore, we should be always anxious, particularly at our final examination, to have men of very considerable mark, who would come down from London, or from the Universities, and superintend the examinations, and keep up the subjects to their proper point.

8782. Would the examinations be conducted under the auspices of the University?—Yes, under the auspices of the University, certainly; but it is proposed that they should take place at Newcastle, on account of the laboratories being there.

8783. (*Dr. Sharpey.*) Such as the medical examinations now are, are they conducted at Newcastle?—Yes.

8784. But some of the University authorities pre-  
side, do they not?—Yes.

8785. (*Chairman.*) If the proposed college at Newcastle should be a success, do you see a probability of other colleges being founded, affiliated in the same manner to your University?—Of course, I should very much desire it. The only place that I had heard of as contemplating a similar plan was Leeds, and there, if they could found a college of this kind, it would be certainly a good thing to affiliate it to us. But, I take it that, when you come lower down south and west, the colleges would very likely connect themselves with Owens College, Manchester, and ours would be for the north and north-east of England.

8786. Owens College is different, in this respect, from Durham, that it has no power of granting degrees; it is not a university?—Just so.

8787. A college at Leeds, or somewhere in Yorkshire, has been talked of for some time, I believe?—Yes, I am aware of that.

8788. Do I understand that the University might possibly consider themselves justified in rendering any assistance towards establishing such a college?—I think if they did not it would be simply from want of funds. Our funds are not large. It would be impossible to do more than to show an interest by giving some slight encouragement. But with regard to the Medical College at Newcastle, we have always been careful not to allow it to consider itself the only medical college in connexion with the University, but have maintained that, if Leeds chose, in the same way, to connect themselves, there would be no difficulty in doing so; and, on similar grounds, I do not at all see why, although we should naturally, from its proximity, assist Newcastle the most, we might not show sympathy by some amount of assistance to a college founded elsewhere.

8789. (*Sir John Lubbock.*) Do you not think that there ought to be a Professorship of Biology in this new Science College?—It would no doubt be very desirable; but we would be simply prevented by want of funds.

8790. Do you propose to make any provision for teaching biology?—That question has been before us as to whether we should try to combine biology with geology and mineralogy; but it appeared to us that it would be only spoiling two good things. The subject is too wide to be well embraced by the same person.

8791. In order to make the scheme complete, I gather that you would yourself consider that there ought to be a professorship of biology?—I was born in the pre-scientific age, and I can only take the opinion of others; but I know that persons, whose judgment I should defer to, consider it very desirable that there should be.

8792. (*Dr. Sharpey.*) Would you not get advantageous assistance from the Medical School in reference to biology; there is a course of anatomy given in the Medical School, I presume, and a course of physiology?

*Very Rev. W.  
C. Luke, D.D.*

19 May 1871



Very Rev. W.  
C. Lake, D.D.  
—  
19 May 1871.

—Yes, we think so, and we hope to get a good deal of assistance of that kind from the Medical School. Unluckily, at present, we are not much in a condition to pay for it.

8793. (*Mr. Samuelson.*) You stated that the project of a school of science in connection with the University of Durham had been entertained for some considerable time, and that ten or twelve years ago the Duke of Northumberland offered very considerable encouragement to the establishment of such a school, but that it fell through in consequence of its having then been intended to establish it in the city of Durham?—Yes.

8794. Was that the only reason why it fell through?—I had not the remotest connection with Durham at that time, and, therefore, personally know nothing whatever on the subject, but, judging from the evidence to which I have before alluded, I should say that it fell through, partly from there being a certain suspicion, on the part of the great employers of labour, of Durham, and also, to put it more generally, from the time for the attempt not having quite come.

8795. From what you have heard since you have been in the north, your opinion is, that the value of training in physical science is much more appreciated by the great employers of labour now than it was at the time of which we are speaking?—I think that it is. It was then very strongly appreciated by some, and nothing could be more forcible, I think, than Mr. Bell's evidence on the subject. Mr. Nicholas Wood felt the same, and I found several persons, as soon as I came into Durham, who held the same opinion very strongly, but I should imagine that some years back the generality of the employers of labour would not have felt it nearly so strongly as they do now.

8796. Mr. Nicholas Wood and Mr. Bell were rather in advance of their time in their appreciation of the value of physical science, were they not?—I cannot say that myself, because I do not know the persons, but they are the only persons who spoke very strongly, judging from their evidence.

8797. They are the only persons who, according to the evidence, seemed to appreciate it at that time, amongst the great employers of labour?—I do not think you have a right to say that, from the fact that we have only their evidence, or to think that their evidence indicates that they were the only persons who felt it; they happened to be the only two persons who were called before the Commission.

8798. They were the only persons who were called, or who volunteered evidence at that time?—Yes, but it must be remembered that all the witnesses were only seven or eight, and their giving this evidence does not imply that many others would not have given the same.

8799. But, at the present day, you find that the larger employers of labour do appreciate the value of such instruction?—Yes, I think the majority of them do very much.

8800. Is it your opinion that the managers, and those holding important situations under them, are also alive to the importance of such instruction?—I have not large means of judging, but, judging from what I hear from persons with whom I talk casually, meeting persons on the railway, and so on, I should say this subject excites a great deal of interest, and that they do feel greatly interested in it.

8801. Have you heard the complaint made at all, that there is a want of scientific knowledge amongst the managers and those who have the direction of those large industrial enterprises in the north?—Certainly, I have. I have heard eminent employers of labour say, "If we could get scientific workmen, it would be an immense boon to us;" but, at the same time that I have heard that, I have heard of one other person, at least, who, when he was asked to give a subscription on the strength of it, said, "Oh no, if it is a financial question, I will not give anything."

8802. He would like to get some one else to educate his managers for him if he could?—Yes.

8803. But, assuming that the need is felt, and supposing that no such institution as the one that you contemplate should arise at Newcastle, do you think there is any chance of its being supplied, by the men of the class of whom I have spoken coming up to receive instruction in London?—You must remember that I have not a very wide experience of the persons you speak of; but, judging from the opinions that I hear expressed by intelligent masters of labour, I should say that there was no chance of it whatever.

8804. That it must be a local school, if it is to be of any value as a technical school?—Yes, to be generally useful, certainly.

8805. Since there are Government schools of this kind in London, the Mining School and the School of Naval Architecture, and those are supported by taxes paid partly at Newcastle, do you think that Newcastle has a fair claim upon the Government for some assistance, less in degree, perhaps, but of the same kind as that which is available for persons of that class in London in the Government schools; and, if the opinion of persons whom you have consulted be correct, that the Newcastle people would not avail themselves of those London schools, is it a reasonable thing to ask that the Government should assist the Newcastle school?—I certainly think that we may fairly claim some assistance, both on account of the practical and useful character of the school proposed, which will not merely promote science, but will also diminish the danger of mining and engineering accidents, and will also benefit many persons of the lower section of the middle class, and some even of the humblest class. And the way in which the question has presented itself to me is, simply that, without the Government assisting the Newcastle school, it will probably be much less efficient than it ought to be, and that it is immensely for the advantage of science generally that a school in a locality which is pre-eminently the centre of great works, should have skilled workmen.

8806. And to do that, you do not consider it would be a sufficient answer if the Government were to say, "Come up, and we will teach you in London?"—No, I do not; amongst other reasons, for this, that they would only get a very imperfect education at the School of Mines in London. They would have to pick the other branches of their education out from different schools about London. They would not get nearly so complete an education as I imagine that they would get by going to Switzerland or by going to Paris, where they might have the whole thing all, so to speak, in one; and, in point of fact, I believe they go a great deal more abroad than they come to London.

8807. You are speaking now of the wealthier class of students, I presume?—Of all classes that I have heard of. I have heard occasionally of persons coming to King's College.

8808. But have you not heard of many persons coming from the north to the School of Mines in Jermyn Street, for instance?—I never heard of anybody, but there may be such cases.

8809. Do you think that a mining school would be better placed at Newcastle than in London?—I think there is room for a mining school at both places. There is, no doubt, a great advantage of one kind in having a mining school in London, inasmuch as you get the ablest men as professors, and men who have made great discoveries, and who, perhaps, are not so fond of coming up to our far north; and, on the other hand, I think that, for the practical purposes of teaching a large body of men, and diffusing a scientific and useful knowledge, Newcastle is a better place. It seems to me that London serves the one end, and Newcastle the other.

8810. But, hitherto, you have not found that the influence of the Mining School in Jermyn Street has been distinctly felt in the north?—You must not make much of my opinion upon the subject, because I really do not know the subject enough; but I certainly have not heard of its influencing education in



the north. Indeed, I may say that I have not heard of it at all.

8811. No doubt you would have heard of it if it had made any great impression?—If it had made any great impression, I probably should have heard of it.

8812. Why has Newcastle been chosen for this purpose, specially, amongst the places in the mining and industrial district of the north of England, seeing that it is on the extreme northern verge of the Durham coal field?—I suppose the first reason has been, that, Durham, being so near and being a University, it was naturally supposed that Durham might contribute help in different ways, help either by recognising the scheme, or positive help by assisting it with pecuniary means. That, I take it, was the first reason. But, then, besides that, it seems to me that Newcastle is even a greater centre for large and varied enterprises than any other northern town that I could name. I, perhaps, may enforce that opinion by reading what Mr. Bell says of it in his evidence, which I was looking over this morning. He says, that “a district, raising, as Newcastle does, a quarter of the entire coal of the United Kingdom, making fully one half, I should say, of all the chemical products, making a large proportion of the glass, and a considerable proportion of the earthenware, producing one fifth or one sixth of all the iron smelted in the United Kingdom, and also being the site of a large engine establishment, requiring, of course, a proper knowledge of mechanics and mathematics, I think there should be no difficulty in providing such an establishment with a sufficient number of students.”

8813. Mr. Bell, there, is claiming for Newcastle all that belongs to the entire district?—Yes, the entire district of which Newcastle is the metropolis.

8814. At any rate, there is the greatest variety of industries carried on at Newcastle?—Yes, I suppose that is the reason.

8815. Even if it should be exceeded in magnitude as regards some individual branches?—Yes.

8816. At any rate, the only town that, as yet, has attempted to negotiate with Durham on the subject has been Newcastle?—Yes, certainly.

8817. Has the question been discussed of adding to the professorships of which you have before spoken, immediately, or in the early future, professorships in mining, civil engineering, and chemical technology?—No, I think not. I think that we have not got so far in the matter of funds as to contemplate that.

8818. You want to confine yourselves, for the present, to the sciences which underlie the applications, rather than to the applications themselves?—Yes.

8819. With reference to the buildings, what is the nature of those buildings?—A very large hall has been building for the last few years which is called the Wood Memorial Hall, which was erected to the memory of Mr. Nicholas Wood by his friends, and, round and above this hall, a considerable number of very good rooms were built by a Joint Stock Company with the view of letting them out for solicitors' chambers; but the situation is very good, and many of the gentlemen who belong to that company are zealous in this matter, and they offer us this cluster of rooms, which are very well adapted for this purpose.

8820. Do you propose to have any boarding houses in connexion with the school?—No. Hitherto the idea has been to leave it entirely as the Scotch Universities are; we might, in time, develop into it, but we find that we have enough on our hands without entering on a plan which, if it failed, might embarrass us.

8821. You have no fear that the absence of those boarding houses would endanger the usefulness of the school?—No; I have the less fear, because a boarding house of that kind was tried in connexion with the Medical School at Newcastle some 10 or 15 years ago, and it was a failure. I may add that I would not be supposed to speak slightly of the advantage of boarding houses, only that we have had, as yet, other things to think of, without devising what is rather a difficult thing to carry out.

8822. I presume there will be no religious tests imposed upon the pupils?—None whatever.

8823. (*Sir J. P. Kay-Shuttleworth.*) Are there any laboratories, or any facilities for creating laboratories, in the building which is at the disposal of the College?—There is a chemical laboratory in the building belonging to the Medical School.

8824. You are aware that the mode in which the great viewers of the north have commonly been educated, up to a very recent period, has been almost exclusively by sending them into the office of some considerable surveyor or engineer, and letting them pass through the practical work of that office, with little or no scientific instruction, excepting that which they might obtain by their own efforts at self-education from books, and with scarcely any external facilities for the illustration of their studies by lectures or class instruction?—Yes, I believe that has been the case.

8825. The instances which you have given of young men who have gone to schools of mines in Switzerland, Germany, or Paris, for scientific instruction have arisen probably at a very recent period?—Yes, they have been probably the sons of the richer parents.

8826. And that has occurred within a very recent period?—Yes, I should suppose that to be the case.

8827. The desire for such more complete instruction, and particularly for the addition of scientific to practical instruction, has not long existed in Newcastle, as far as you know?—Probably not, except in the case of individuals.

8828. At present, probably, the Council, or other body which is in consultation as to the future constitution of the scientific school at Newcastle, may not have determined the exact relations which the scientific instruction shall bear to the practical instruction in mines, engineering works, glass works, and other manufactories which exist in Newcastle or in the neighbourhood?—No, we have not considered that, because we have so many men of eminent practical skill amongst us that we are pretty confident that they will be able to adjust that.

8829. You leave those questions to be hereafter developed by your discussions, and by the experience of the district, combined with the advice of the scientific professors?—Yes. The only difficulty which I at all apprehend is, from a fear which I have heard expressed, that employers of labour may not, in all cases, offer facilities to young men for attending lectures. But I have no doubt that satisfactory arrangements will be made on this point.

8830. You are aware of the very strong opinion which has been expressed by Sir Joseph Whitworth, through his experience as an engineer, that scientific instruction should be combined with the education of the hand and of the eye in the art, at the same time that the science of any particular department of industry is acquired?—The only thing that I remember to have heard bearing on that point is, that Sir Joseph Whitworth found considerable difficulty in arranging for the young men who were articulated to him to attend the science lectures, and, of course, that is a possible difficulty which we may feel also. I mean, that, at the present time, young men are articulated, I believe, for a certain time to some eminent engineer, and there may be two points doubtful, first, whether, supposing they had been to our college for two years, he would be disposed to allow those two years to count for a part of the term that they were with him. Secondly, supposing they had not been to our college, whether he would so arrange as that they might attend for a certain number of days in the week, or days in the month, at the college, and a certain number of days in his workshops.

8831. The view that has been taken by eminent practical witnesses before this Commission has been the following, that after a young man had obtained the elements of a sound English education he should first be put into the workshop, in order that it might not thenceforth be irksome to him to encounter the dirt, and the fatigue, and the other annoyances of a workshop; that after having become accustomed to

Very Rev. W.  
C. Luke, D.D.

19 May 1871.



Very Rev. W.  
C. Lake, D.D.

19 May 1871.

that, he should be sent to receive scientific instruction, which should be continued without interruption for a period of two or more years, and subsequently to that he should be sent back to the workshop to complete his manual skill and his knowledge of the art of the particular branch of industry to which he had to apply himself, and, then, that, at a later period, he should complete his scientific and technical instruction; but, as yet, neither the Council of the University of Durham nor the Council of the Science School have entered, perhaps, into the details of this question?—That appears a reasonable plan, as you state it, but certainly we have not entered into it because really the thing has been on foot so short a time that we have not come to that point.

8832. It is obvious that it is extremely important to reconcile practical men to the idea of high scientific instruction, in consequence of the prejudice that exists that that instruction does unfit a man for the practical labour of a particular branch of industry or art?—Yes; but I have not found that prejudice, except in one or two cases, among the leading employers of labour with whom I have come in contact.

8833. (*Dr. Sharpey.*) Have I understood rightly that the arrangement at present contemplated is to be on a temporary footing?—No; the arrangement now contemplated is to be on a permanent footing, that is to say, the arrangement as to the existence of the College; but we hope to add fresh professorships.

8834. Is it expected that you will soon be able to make a beginning?—We hope to open in October.

8835. (*Professor Smith.*) It is intended, is it not, that the School of Science should have, to a certain extent, the character of a mining school?—Yes.

8836. I wish to put to you, whether you do not think that you might increase your claim upon the Government for assistance (a claim which I understand you to say you think is a strong one), if you were to embrace that character in the school; I mean considering the importance of the mining interests of the north of England, if you could see your way to the establishment of a professorship of mining, and mining engineering in particular; because, without a

professorship of that kind, it might be said that you were hardly constituting yourself sufficiently into a mining school to be supported by the Government on the ground of the importance of the mining interest?—Certainly, if that be so; but, I believe, the professorships we propose to form are considered by mining engineers to be very valuable for their profession.

8837. There is not a feeling there, that a professorship of mining engineering, or any teaching of that kind, is strongly required by the mining interest?—There is a feeling that one or two other professorships would be very desirable, only that those four professorships, as lying at the foundation, are the most desirable of all, and that these professorships are the only ones for which we have at present got the money.

8838. But no strong desire has been expressed for a professorship of mining engineering, as compared with the various other professorships which it is quite clear it would be desirable to establish?—Not as compared with the existing professorships, nor, I should say, as compared with the professorship of biology. I think that has been the most pressed, after the professorships which we have already determined to endeavour to found.

8839. (*Chairman.*) Have the more prominent of the promoters of this College been found amongst those directly connected with the College, or rather with those connected with the great ironworks and glass works that have arisen in the district?—I should say as much from the one as from the other. I could name as many from the collieries as from the great ironworks.

8840. With regard to Professor Smith's question, the consideration of appointing a Professor of Mining would not have been overlooked in consequence of the project not receiving support from those directly connected with the College?—No, certainly not. We are all desirous to establish just those professorships which will be valuable to the great works of the North.

8841. Are there any other points upon which you could give the Commission any information, and which we have not yet referred to?—I am not aware of any other points.

The witness withdrew.

Adjourned to Tuesday the 6th of June next.

6, Old Palace Yard, Westminster, Tuesday, 13th June 1871.

PRESENT:

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

SIR JOHN LUBBOCK, Bart., M.P., F.R.S.

SIR JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

GEORGE GABRIEL STOKES, Esq., LL.D., Sec. R.S.

HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

Mr. GEORGE JARMAN examined.

8842. (*Chairman.*) I believe you are a Teacher of some of the science classes in the Mechanics' Institute at Huddersfield?—Yes.

8843. Have you had several years' experience of the examinations in science under the Science and Art Department?—Yes, since the examinations were commenced.

8844. Do you consider that you have, at present, a sufficient guarantee of the fitness of candidates for the office of science teacher?—No, not in the present mode of examination. The examination, at present, for the office of science teacher, is a paper examination only. I think that there should be some other kind of examination, or some probationary period which the candidate should pass through before he becomes a science teacher: a pupil teachership, for a year or two, would do him good.

8845. Have you had any experience of the working of a system such as you would like to see more generally adopted?—I have myself had assistants to help me to prepare the experiments for my lectures, and to perform the experiments, and I have found such students do well in the examinations, and, when they have become teachers, they have made more efficient teachers than others who have merely passed in the paper examination.

8846. Have you taken them as assistants after they have passed the the examination under the Science and Art Department?—Usually after they have passed the elementary stage—the first examination.

8847. Have you a large number in the classes of which you have had experience?—No, seldom more than from 20 to 30, and I think that is quite enough to form a class.

Mr. G.  
Jarmain.

13 June 1871.



Mr. G.  
Jarmain.

13 June 1871.

8848. In the instruction of a class of that number, do you find that the assistance of pupil teachers is desirable for the sake of training the teachers, or for the sake of the students as a class?—For the sake of training the teachers, I think a teacher should undergo some such probationary work as that. In many cases, I have known young men begin to teach who had never done anything in experimenting, and were, therefore, unable to illustrate what they taught.

8849. When you have employed such pupil teachers as you have been speaking of, have they been remunerated in any way for the assistance which they gave you?—No.

8850. Have you found young men willing to serve in that capacity without any remuneration?—Yes; I have had no difficulty in obtaining such assistance.

8851. Do they consider that they will be trained thereby to become more efficient schoolmasters?—Yes; and they have thought themselves sufficiently repaid by the extra attention which they received.

8852. Do you know whether a system such as you recommend has been adopted at all generally in Yorkshire, or in the populous districts in the north?—I am not aware that it has been adopted anywhere else.

8853. Would you like to see a system of that kind made compulsory, that no one should be allowed to undertake the management of a science class who had not previously served as a pupil teacher?—I should very much like to see some such system carried out, and applied generally.

8854. Besides your regular classes, have you also taught special classes of schoolmasters?—I have.

8855. Are those schoolmasters the teachers of elementary schools?—Yes, mostly teachers of elementary day schools and National Schools, but I have had some teachers of private schools as well.

8856. Has that been in any way in connexion with the examinations of the Science and Art Department?—Yes.

8857. Did those schoolmasters intend to go into the examination?—They joined the classes with the intention of becoming teachers of science.

8858. And you would be entitled to payment on results for the examinations passed by those teachers?—Yes; I received in most cases payments on results.

8859. Have you had any experience of the results of your teaching in those special classes with regard to the success which has attended their teaching subsequently?—I have lost sight of most of them, for my science classes for schoolmasters were in Leeds, Bradford, Halifax, and Wakefield. I live in Huddersfield, but I know that in many cases the masters have become teachers of science classes; and, in the instances with which I am acquainted, they have been successful, but I should have liked to have had an opportunity of training them in experimental work.

8860. What are the subjects in which you have yourself taught?—Most of my observations apply to classes for chemistry.

8861. Do you find, with respect to the classes of schoolmasters, that they are inclined to depend mainly on book work?—Yes, they are too much inclined to depend upon book work; they are not apt at experimenting; they do not seem to take up the experimental sciences well.

8862. What methods have you adopted to counteract that tendency?—Only having had them one session, I have had no opportunity of making them work, except in the case of the Leeds class, where I have had several schoolmasters under my instruction in laboratory work, in analysis, and in practical chemistry, during a second session.

8863. Have those schoolmasters come to Huddersfield from Leeds to attend your classes?—No, I went to Leeds.

8864. Have you an opportunity of making use of a laboratory at Leeds?—Yes; not during the year in which I was training them to become teachers, but in the following year.

8865. Did you go over a second year in order to assist them in getting experience in experimental work?—I opened a class in Leeds during the second year, and many of the schoolmasters who had been my pupils during the first year joined my class afterwards, in order to obtain practice in experimental work.

8866. With respect to mechanics' institutions, do you consider them the best places in which science may be taught to the artisans?—Yes, there are no better institutions, I think, at present. They seem, to me, to be the proper places where science ought to be taught to artisans.

8867. Is most of the science teaching in Yorkshire connected, either directly or indirectly, with mechanics' institutions?—In the night classes it is, but there are some science classes in schools during the day.

8868. Have the mechanics' institutes, generally, taken any steps for the encouragement of science teaching, independently of the examinations under the Science and Art Department?—Yes, there were science classes in many of the mechanics' institutions in Yorkshire before the Science and Art Department began their examinations.

8869. What success attended those classes?—They had not many students, but some of them turned out very well. The teachers, I think, in all cases that I am acquainted with, were voluntary teachers.

8870. Without any payment whatever?—Without any payment.

8871. Was there no fee from the students?—Yes, the students paid a fee, but that went to the institution, and to provide apparatus.

8872. Does that system continue at present to any extent?—No, not since the examinations by the Science and Art Department.

8873. Do all the teachers now take advantage of the Science and Art System?—Yes. I do not remember a case in which that is not done.

8874. Has the character of the teaching at all varied since the establishment of the Science and Art Department Examinations?—It has improved very greatly.

8875. Are the teachers better qualified?—Yes, the teachers are certainly better qualified.

8876. Besides the classes which you teach, are there other science classes connected with the Huddersfield Institution?—There are.

8877. Are the students in those classes members of the mechanics' institute, or do you take persons who are not otherwise members of the institution?—Very few of the students of the science classes are members of other classes of the Huddersfield Institution. The members of the Huddersfield Institution are engaged in elementary work. Many of them are but learning to read and write and to do arithmetic, and are not sufficiently advanced in elementary education to take advantage of the science classes.

8878. Do many join the institution to make up for the deficiencies in their elementary education?—Yes, very many of them have not been at a day school at all.

8879. But science classes, I presume, are generally composed of persons who have received a tolerable elementary education?—Yes.

8880. Is any fee exacted from the pupils of the science classes?—Yes. In my case the fee is 5s. a session for artisans, and 15s. for middle-class students. Besides that, they have to pay the institution fee, which will amount to about 7s. in addition to the 5s. and the 15s.; that is for the winter session, from October till May.

8881. Are the teachers of those classes generally persons who are qualified under the regulations of the Science and Art Department?—Yes, in all cases.

8882. In fact, they would not be able to obtain payment on results unless they were so qualified?—No.

8883. Have the Committees of the Institutions with which you are acquainted had under consideration the possibility of making instruction in science more general among all the members of the institutes?—They are very anxious to do so, and they are dis-



Mr. G.  
Jarmain.

13 June 1871.

curring the subject at the present time, but I think they have not as yet arrived at any definite conclusion as to the course to be pursued.

8884. Do they contemplate something different from what is in existence at present, or merely that it should be more general?—They contemplate carrying out the plans more generally.

8885. Would they make it compulsory on all the members of the institute to attend some classes?—No, I do not think that they have arrived at that conclusion. They intend to enlarge their premises when possible.

8886. Do the members, as far as your experience goes, generally join the institutes and become members with the view of acquiring instruction in some form or other?—Yes, it is a serious work with them; they have to pay for it, and they would not pay what they do unless they expected something in return.

8887. Can you point out the nature of the steps which they think it would be practicable to adopt with the view of making attendance upon those classes more general?—They think that when education improves, as they hope it will do by-and-by, there will be a greater demand for scientific instruction.

8888. But do they think that it is in their power to take any steps to further such general instruction in science?—They have an impression that they can improve the science instruction in the neighbourhood by making better provision for the classes, by having better rooms and better apparatus, but they look forward to this when the general education has improved. They do not expect that it will increase to any extent for some time to come.

8889. Besides the classes, as to which you have already spoken as having been conducted by you, you have also conducted classes, I believe, of a somewhat different description—more of a directly technical character?—I have.

8890. Can you describe the nature of those classes?—The best description that I can give is in a letter which I wrote to the Department of Science and Art, and which Mr. Iselin includes in his Report of 1870, at page 61. [*Seventeenth Report of the Science and Art Department.*]

8891. Could you state to the Commission, in a short form, some few of the principal results that Mr. Iselin refers to, as having been accomplished by those classes?—The dyers in the West Riding of Yorkshire are very deficient in technical knowledge, and they are very often puzzled in their work, on account of not knowing certain chemical principles. Mr. Akroyd, the Member of Parliament for Halifax, wished me to establish some technical classes in connexion with the Haley Hill Working Men's College, in the year 1868. I recommended that a class for the chemistry of dyeing, scouring, and bleaching should be established, and he desired me to carry that plan out. We advertised in the papers, and some 40 pupils presented themselves for instruction in the chemistry of those three branches of technical industry. After carrying the plan out in Halifax, I was requested to do the same in Huddersfield, where we had a very successful class. Many of the manufacturers' sons joined the class, in addition to foremen and head workmen employed in manufacturing operations. I also afterwards had a class in Leeds of the same kind, in connexion with the Leeds School of Art and Science, which succeeded pretty well, though not so well as the classes in Huddersfield and Halifax. It was my endeavour to bring before my pupils the chemical principles involved in the different processes that they had to perform in the dye-house and in the manufactory, and the plan that I pursued is described in the letter to which I have referred.

8892. Is the formation of such classes as those which you have last been speaking of in any way encouraged by government assistance?—No, not at all.

8893. Had most of the students who attended those classes of which you have last been speaking previously passed through the more elementary classes under the Science Department?—Yes; many of the students had

already passed the elementary examination, and those, I found, I was much better able to teach than others who had not had such previous training in science.

8894. How was the means found of supporting those classes?—Mr. Akroyd paid me a salary in Halifax; the fees paid by the students paid me in Huddersfield; and I had a salary for my class in Leeds, given by the Committee of the Art and Science Institution.

8895. Are those classes likely to be continued?—I shall continue them. I commenced a class last October, in Leeds, but I was involved in a railway accident during the latter part of the month and had, in consequence, to discontinue it.

8896. Have any similar classes been established by any other teachers?—I am not aware that the plan has been tried anywhere else.

8897. (*Mr. Samuelson.*) Is there not something of the same kind at Bradford?—I am not aware that there is. I had made arrangements with Mr. Miall of Bradford, who has now removed to Leeds, to take a similar class at Bradford, this summer, but on account of my accident I have not been able to carry it out.

8898. (*Chairman.*) Are you of opinion that there is any feeling amongst many of the chief employers that the establishment of such classes would be desirable?—Yes, they all believe that such classes are desirable.

8899. Do you think that they would be willing to find the means for establishing such classes?—I think so; they are not unwilling to pay a good fee. I had some eight or ten of the principal manufacturers' sons in Huddersfield in my technical class.

8900. They would be a class above those that the government would pay for in any way, would they not?—Yes.

8901. Did any that could be considered of the artizan class attend those classes?—Yes, about two thirds might be considered of the artizan class, and one third of the middle or upper middle class.

8902. Do any of the middle classes attend the classes under the Science and Art Department?—They do.

8903. But you are not entitled to payment for teaching them?—No, I charge an increased fee in their case.

8904. (*Sir J. Lubbock.*) Do you consider that the Science and Art Examinations are a fair test of the acquirements of the pupils?—Yes, so far as a paper examination can do it. I should like to see an examination in practical science as well, if it could be done; and I think it might be done in chemistry. A practical examination in chemistry is enforced by the Cambridge Middle-class Examinations.

8905. With reference to the masters, I understood you to say that, in your opinion, a pupil teachership, for a year or two's training, would be very desirable?—Very desirable, indeed.

8906. Quite agreeing with you in that point, would you make it a *sine qua non*?—Yes, I would, indeed, at present. I think the time has come now.

8907. You would not be afraid of discouraging the system by introducing such a measure as that?—No, I do not think it would discourage the teachers; it would make them rather more proud of the office than they are at present.

8908. Do you think that there is any disadvantage in gentlemen going in for certificates in a number of subjects, under the Science and Art Department? We have it in evidence that some gentlemen hold certificates in a considerable number of subjects; do you regard that as an advantage?—No, I think not.

8909. You think it better that they should confine themselves more to some special subject or group of subjects?—Yes, to one group of subjects.

8910. That is, supposing they took the certificates with the view of teaching?—Yes.

8911. I presume, if they took them with a view to general culture and without the intention of teaching, you would consider it on the whole to be an advantage?—Yes, certainly.

8912. As regards the machinery of examinations, and the supervision which is exercised by the Committee, do you think, on the whole, that the system



works tolerably well, as it is at present carried out?—Very well, indeed.

8913. You do not think that any material alterations are necessary?—I cannot suggest any improvement, except that, in the case of teachers, I think I should have two or three questions specially bearing on the art of teaching.

8914. You mean that you would require such questions to be put before the certificates, enabling gentlemen to teach, were given?—Yes; any candidate for the office of teacher should be required to answer two or three questions on the art of teaching.

8915. But you stated, did you not, just now, that you would make a pupil teachership for a year or two a *sine qua non*?—Yes, and that in addition.

8916. Do you not think that two years would be too long a time to insist upon, in all cases?—One year would do them a great deal of good, but I think two years would be better; but I would insist upon one year, in all cases.

8917. I think I understand you to say that, in your opinion, the Examinations under the Science and Art Department, on the whole, are well and carefully conducted?—On the whole, as far as I know, they are very fairly conducted. The Committees under which I teach are most anxious that the examinations should be carried out according to the letter.

8918. And you think that that is the case, on the whole?—I believe it is.

8919. Do you think it necessary or desirable that there should be any inspection of the schools, as apart from inspection during examination, or would you leave the schools to be tested by the result of examination?—I think that an inspection of the schools by some gentlemen acquainted with the subjects taught would do good.

8920. And they would, probably, be able to suggest some points, from their own experience, which would be useful to the teachers?—Yes, I think they would.

8921. I gather that you think that would be desirable, but you do not regard it as being necessary under the existing state of things?—Not necessary, but very desirable.

8922. If I remember right, in the evidence which you gave before Mr. Samuelson's Committee in the House of Commons, with reference to elementary schools, you expressed an opinion as to its being perfectly possible to teach a certain amount of elementary science in the elementary schools of the country?—Yes, to the upper classes of the school. I tried the plan during the time that I had a school, and I found it to answer very well.

8923. From the age of 11 to 13?—Yes.

8924. That is a point which you feel no doubt upon whatever?—I feel no doubt upon it whatever.

8925. Did you try it in chemistry?—Yes.

8926. But, I presume, you would consider that there would be no more difficulty in applying it to botany or physiology than in the case of chemistry?—No, I do not.

8927. Do you think that the teaching of one or two such subjects would in any way interfere with the instruction of children in the elementary subjects of reading, writing, and arithmetic?—No, I do not think it would. I think that the pupils would like it very much. As a rule, boys very much like scientific instruction.

8928. It would give them, would it not, a greater interest in their school education, as a whole?—Yes, I think so.

8929. And, in that way, would have a decidedly favourable influence upon their reading and writing?—In two classes that I have at the Huddersfield College and the Huddersfield Collegiate Institution, the boys who are in the chemistry class I find to be the best boys in the school in other subjects.

8930. And you are disposed to think that, without saying that it would hold good in all cases, that would be found to be the general effect?—I think it would.

8931. (Mr. Samuelson.) I gather, from your evidence, that you are not satisfied as to the sufficiency

of the examination of teachers of science at present?—I am not.

8932. And you propose to supplement that by what may be called an apprenticeship to teaching?—Yes.

8933. But, there being no guarantee that the present teachers are efficient, do you really think that much good would be served by compelling persons to be placed under others of whose efficiency you are not convinced?—There is a little difficulty about that, certainly, but that is the fault of flooding the country with teachers.

8934. I suppose you would not place those pupils with everyone who is now authorised to teach (qualified is the term that the Department uses), but with selected teachers of whom you knew that they were fit to conduct classes?—Yes, with teachers who had had classes, say, some three or four years.

8935. In a thinly-populated district, would there not be some difficulty in finding qualified persons under whom you could place those who were candidates for becoming teachers?—Yes, in thinly-populated places there would be a difficulty.

8936. So that this plan of yours would be more adapted to the West Riding of Yorkshire and to East Lancashire than to the country at large?—Yes.

8937. But, if you had, in various centres, such institutions as Owens College at Manchester, or the proposed Science College for Yorkshire, would it not be at least as good a plan to allow young men to qualify themselves in such colleges, as to place them under teachers who may themselves be more or less accomplished?—I think they would be better prepared for their work, if they had first an apprenticeship such as I have spoken of.

8938. You mean in such districts as yours?—Yes, they would be specially prepared for the special work which they had to do.

8939. You consider that young men, with less knowledge, specially prepared in this way would make better teachers for elementary classes than men of greater acquirements who had not had this special training in teaching?—Yes, I think in most cases it would be so.

8940. But, of course, if in the colleges they had an opportunity of teaching, and, at the same time, had more advanced instruction, then the combination of the two things would be what you would consider relatively perfect?—It would improve my plan considerably.

8941. Have you made any estimate of the value of the instruction which is given to teachers at the periodical classes held at South Kensington?—I have attended this periodical instruction, and I have received very great benefit myself from it. I think I have attended three times during the summer months.

8942. In what subjects?—In chemistry.

8943. Were you associated at all with the other gentlemen who came up for instruction there?—We were employed in the laboratory during the day, in addition to having lectures in the evening.

8944. Were you able to form any opinion as to whether those gentlemen were generally sufficiently advanced in their subjects to be able to derive considerable advantage from those classes?—Out of some 300 who came up to the lectures last year, we had only about 30, speaking from memory, who attended the laboratory instruction.

8945. Were those 30 selected in any particular way?—No. They elected to receive laboratory instruction. They all seemed very earnest about their work, and, like myself, they expressed very great satisfaction with the instruction.

8946. Did you look upon those as, in any sense, selected men?—No.

8947. If any difficulty should arise as to accommodating as many teachers as offer themselves, can you suggest any mode for making a selection amongst them?—No, I cannot, unless the teachers were selected from districts where the science that the teacher is teaching is of very great importance, as in our great centres of industry. I think, perhaps, it would be very desirable if those teachers were selected

Mr. G.  
Jarman.

13 June 1871.



Mr. G.  
Jarmain.

13 June 1871.

before others whose teaching would not be to such good purpose in the particular district where they might be placed.

8948. Do you mean commercial advantage?—Yes.

8949. (*Professor Huxley*.) You are doubtless aware, that this year the Department found it requisite to make a selection, in consequence of the number of applications of persons who wished to attend the summer course?—Yes, I am.

8950. And an attempt was made to make that selection, by causing the person who wished to come up to take an honours paper in two departments?—Yes.

8951. Do you think that that was a desirable step, and one likely to work well?—It is my impression that it will not work very well.

8952. For what reason?—In many cases teachers will not care to go in for an examination again.

8953. But you will perceive that the Department are placed in a difficulty, by having a very much larger number of applications than can possibly be granted?—Quite so, and I think, as I have just now stated, that the selection might be made of teachers who would be likely to do most good being placed in particular districts where science instruction was much wanted.

8954. But in the case of physiology and biology, it would be hard to say that it was more wanted in one district than in another?—Just so, but in the case of chemistry you might put your finger on the places where it would be most required.

8955. But in the particular case about which those difficulties exist, take physics and biology, instruction in which is about equally needed everywhere, it would be a very difficult task for the Department to adopt any principle upon which to make their selection, except that of examination?—Yes, in that case, I think it would.

8956. (*Mr. Samuelson*.) In such subjects as chemistry, if you were to give the preference to certain districts, of course you would not make it a permanent preference, but you would take other districts in their turn?—Yes.

8957. Apart from the question of the pupilage which you propose, do you think it would be an advantage that teachers should be able to come up for instruction to more centres than one?—Yes, I think it would be very desirable to have a centre in Manchester, and another in Birmingham; certainly more centres than one, and more than one or two schools.

8958. Without entering into the question as to how far the government may be called upon to give assistance to science colleges, as such, do you think it would be desirable that they should give some aid to such colleges, specially, in consideration of their giving instruction to science teachers?—Yes, for the training of teachers, I think so, decidedly. I think that the instruction in science will be very much as you instruct the teachers throughout the country.

8959. With reference to the inspection of science schools, do you consider it desirable, or not, that the Department should ascertain whether those schools are sufficiently furnished with the means of giving practical instruction?—Yes, I think that unless they are provided with such means, instruction ought not to be given; it will be mere book work.

8960. You are aware, are you not, that some encouragement is now given to schools to acquire apparatus?—Yes, there is no excuse now for any class being without proper apparatus.

8961. Then, would you say that in those subjects in which apparatus is needed you would not allow new classes to be formed unless it were ascertained that the apparatus was provided?—Certainly. I would not make any grant to such schools for such classes.

8962. How would you deal, in that respect, with existing classes; would you shut them up?—I would give them a certain time, due notice, to provide themselves.

8963. And if, after a certain time, they fail to do so, would you cease to make any payments in respect of results in those classes?—Yes, I would.

8964. You would not receive their papers at all?—I would receive their papers, but I would not make any grant.

8965. Have you thought much on the propriety of discontinuing the grants to classes insufficiently provided with the means of practical teaching?—I have not thought much about it. It strikes me that now it would be the proper course to compel Committees or teachers to provide their classes with sufficient apparatus under the penalty of withholding the grant if they did not do so.

8966. Have you thought sufficiently about it to enable you to give that as a definite opinion?—Yes, I have.

8967. You gave evidence before the Committee of the House of Commons with reference to instruction in elementary science in elementary schools, and you have supplemented that evidence to-day, do you think it possible to give such instruction in half-time schools?—I fear that it would be taking too much away from the limited time that the half-timers have to acquire elementary education. I think I should leave the half-timers to acquire their scientific instruction in the night classes after they ceased to be half-timers.

8968. Then you do not share the opinion that those schools are capable of teaching as much up to the age of 13 as full-time schools?—No; I do not see how they can.

8969. And you say that, as having had some experience of the results obtained in half-time schools, although you have not yourself been a master of such a school?—I have not been a master of such a school, with the exception of having had about a dozen half-time scholars in my school during the last two years that I was a schoolmaster.

8970. But you live in the centre of, and are surrounded by, such schools, and you know how they work?—Yes, I do.

8971. Then you would relegate instruction in science to the night classes?—Yes, in the case of half-timers.

8972. Do you find that the half-timers, as a body, are willing to attend night schools?—A very large proportion of those who attend the mechanics' institution in Huddersfield are boys who are employed during the day in some manual work, but the proportion of half-timers is small.

8973. What proportion do you suppose that those boys bear to the industrial population?—At present the proportion of half-timers is only 1·3 per cent. of the total number in attendance.

8974. Hitherto, under the regulations of the Whitehall Department, no aid was granted to evening classes, unless held in connexion with some day school; but that has been changed, has it not, by the Code of 1871?—Yes.

8975. Do you consider that to be a great improvement?—Yes, it will be very beneficial to the mechanics' institutions throughout the country; they will be able to carry out more efficiently their plan of education.

8976. Do you think that, indirectly, it will have an influence also upon the science classes, by preparing a greater number of young men to take advantage of them?—The institutions will be able to obtain the services of better teachers, and the instruction will, I have no doubt, be better in every respect.

8977. And may lead up to instruction in science?—Yes.

8978. (*Professor Stokes*.) Did I rightly understand you to say that there has been an improvement in the teaching of science since the operations of the Science and Art Department?—Yes, a very great improvement.

8979. Do you mean with reference to the qualification of teachers?—Yes, both with reference to the teachers and to the pupils also.

8980. Are the teachers that you have chiefly in your mind those who have qualified under the old system in which they were specially examined, or those who are qualified by merely taking a first-class certificate?—Those I have in my mind now are those who



have been engaged in teaching for some three or four years, at least.

8981. But as regards the operation of the Department, in what way have they qualified to be allowed to teach?—Those who were teachers before the rule came into operation for making everyone who had passed the advanced stage into a teacher, if he thought proper to become one, are the teachers that I had in my mind when I made that statement.

8982. (*Dr. Sharpey.*) In the Huddersfield Mechanics' Institution, besides the chemical apparatus which is available there, is there a good supply of apparatus for experimental physics?—Yes; not in my opinion sufficient, but still a very fair amount.

8983. Is there any collection of natural history?—No, not yet; but we have another institution in the town which takes up that subject, where we have a small museum, and I am connected with that institution too, that is the Huddersfield Literary and Scientific Society, where we have a small collection of geological specimens, and we have a field club in connexion with that institution and we have short excursions into the district for the study of botany, entomology, and geology on Saturday afternoons.

8984. Is the collection there available for your students, if they should wish to take advantage of it?—Yes, it is.

8985. In the Mechanics' Institution, is there a tolerable library?—There is a good library.

8986. And how is all that maintained?—By annual subscriptions and the payments of the pupils. The pupils pay about 3½d. per week, and their number is 750. Nearly all the pupils belong to the working classes, and about 300 of these, called presentees, paying 1d. per week, many of whom are orphans, receive their education at this low rate by means of the guinea subscription of the annual members.

8987. Could you give us any notion of what a sufficient apparatus for very elementary instruction in chemistry in an elementary school might cost?—About 5l., for illustrating the principal facts of chemistry, would be sufficient.

8988. (*Professor Smith.*) As you seem to think that so small a sum might be sufficient for the smallest amount of apparatus that might be absolutely necessary, you probably are of opinion that if the Department were to require that each class should possess that amount of apparatus, this requirement would not have the effect of discouraging a considerable number of the elementary science classes now existing?—Yes, certainly, taking into account that they make a grant of one-half as well. I do not see any excuse for a class not being provided with proper apparatus.

8989. And do you think that this requirement ought to be enforced in all cases?—Yes, I think it ought.

8990. You have already referred, I think, to the importance of rendering some part of the South Kensington Examinations of a practical kind, by insisting upon some experimental or practical work in connexion with the examination?—Yes, I have already referred to that. I think it desirable that, if it could be done, an examination in practical science should be

made, and I do not see any difficulty in doing it in the case of chemistry.

8991. Would you explain how you think that could be done in the case of chemistry?—A student who was prepared to undergo that examination should be required to have a certain set of apparatus, or the institution should provide them for the student. In many cases the institution might be provided with the apparatus necessary for his practical examination, and then all that would be required by the Department would be to send down specimens of substances to be examined and reported upon by the pupils. I would carry it on very much in the same way as the Cambridge Middle-class Examination in practical chemistry.

8992. Would you think it necessary to have this practical examination for the elementary as well as for the advanced stage?—No, only for the advanced stage.

8993. Do you think that you could have an examination of that kind at nearly all the places where the South Kensington examination is held?—Yes, especially if they were required to have a sufficient supply of apparatus at the place. I do not see that there would be any difficulty then.

8994. You mentioned that some of the students who attend your technical classes belong to the middle classes, and some to the artizan classes?—Yes; and I have some of the middle classes in my ordinary science classes as well.

8995. Could you give us any idea of the proportion of the number of persons belonging to the middle classes compared with those of the artizan classes?—In the technical classes about one third of the whole number would be of the middle or upper-middle class, and the others artizans. In the ordinary science classes, speaking from memory, and speaking of all my classes together, I think about one fourth would be students for whom I could obtain no grant, and from whom I require an extra fee in consequence.

8996. (*Chairman.*) Can you employ, at the same time, any considerable number of pupil teachers, without inconvenience, in your classes?—No, I do not think that a teacher would do very well with more than two at a time.

8997. Is that the utmost that you have ever had in your class?—Yes.

8998. Have you had any experience of science classes in districts of a more rural character, or in small towns in agricultural districts?—Yes, I have had in small towns, not in agricultural districts. I have lived in an agricultural district for some years, and I know their wants pretty well. I think that classes for agricultural chemistry would be a very great benefit to farmers.

8999. Under existing circumstances, would what you consider desirable have the effect of putting an end to many of those classes in such districts?—No, I do not think so.

9000. Is there any other point upon which you desire to add to your evidence?—No, I do not think of any just now.

The witness withdrew.

P. LE NEVE FOSTER, Esq., M.A., examined.

9001. (*Chairman.*) The Commission are anxious, in the first place, to know whether the Society of Arts had taken any steps for the encouragement of instruction in science before the system commonly known as that of the Science and Art Department was established?—Yes, it had.

9002. Will you be so good as to explain to us what steps were taken?—In 1852, on the suggestion of the late Mr. Harry Chester, the Society took up the Mechanics' Institutions in the country and formed a union of them, with the view of getting into those institutions more real educational work, more systematic instruction than had hitherto been the case; and having done that, one of the modes adopted of getting instruction of that kind given was to give a stimulus

to it by the establishment of examinations, with prizes for those parties who, studying in the classes at those various institutions, should distinguish themselves. That was done in 1852, but it was not until 1856 that the system of examinations was brought into play, and it then began in a very small way. We began it in the Society's own house in the Adelphi, and I think we had 52 candidates only. The next year we had two centres of examination, one in London and one in Huddersfield, and there were 80 candidates in London, and 140 at Huddersfield. Afterwards, in the year 1858, we thought it desirable to endeavour to extend the system, so that it could be taken advantage of readily by many more than those who could come either to London or to any one or two

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13 June 1871.

established centres. We desired to bring the examinations home to every man's door, if possible, and we then started a system which has subsequently formed the basis of the system of the Science and Art Department. That is to say, we said, wherever a mechanics' institution, or an institution of an analogous character, will establish a responsible local board to superintend the working of the papers, we will send down papers prepared by the Society's examiners to them to be worked, and afterwards their respective merits will be tested by the examiners, and we gave prizes for them and certificates of three classes. That was extended from time to time, so that we got to have something like 140 of those local boards, as we called them, throughout the country at which our examinations were held. The examinations were held simultaneously at all the centres, the days and hours and subjects being fixed for all alike. With regard to those examinations, probably, so far as this Commission is concerned, it would be interesting to them to know what the subjects were that we took up, because we not only took scientific subjects, but we had literary subjects as well, and I will, therefore, give you a list of the subjects, taken from one of our late reports. We had arithmetic, the principles and practice of the metric system, book-keeping, algebra, geometry, mensuration, trigonometry, conic sections, navigation and nautical astronomy, the principles of mechanics, practical mechanics, magnetism, and electricity, light and heat, chemistry, mining and metallurgy, botany, floriculture, fruit and vegetable culture (we took the practical applications as well as the scientific part), animal physiology in relation to health, and we had domestic economy (for I should say that our examinations were open to females), political economy, the civil government and laws of England. All the other subjects were literary subjects, including languages, history, geography, and logic. The great object that we had was to get the mechanics' institutions to supply classes for instruction, so that those who left school at an early age, say at 12, might be able to continue their education afterwards, and we thought that by this system of examinations we should excite them to attend those classes. We admitted no candidates under 16. The numbers that came to us ultimately were rather more than 2,000. Finding, however, two years ago, that the Government examinations were going on side by side with us, or, rather, going on far ahead of us in all the scientific subjects, we thought it desirable to give them up entirely into the hands of the Government; and, at the present time, we are only examining in some of the practical applications, such as floriculture, horticulture, domestic economy, and certain literary subjects, but all the scientific subjects we have handed over to the Government, who were carrying it out by thousands where we were doing it by tens.

9003. Have you any suggestions which you could offer to the Commission with respect to the examinations under the Science and Art Department?—They are carried out very much upon the same principle as ours were, except the limitation as to age. They had all our forms to start their examinations from.

9004. Did you make any attempt to make your examinations partly of a practical character, as well as testing the acquirements of the candidates by answers to written questions?—Only by answers to written questions.

9005. Then your examination was not in any respect of a practical character?—Not at all; not like the Whitworth examinations for scholarships.

9006. Do you think it would be possible to make the examinations under the Science and Art Department, in any degree, more practical than they are in any of the branches of examination?—I have not looked sufficiently into that to answer the question fairly.

9007. I mean, would it be possible to require something more from the candidates than answers to ques-

tions in printed papers?—I am not aware of anything.

9008. Do you think that the system, as far as you have had an opportunity of judging, is producing much beneficial result in the country?—I should think it is, from what I have heard.

9009. (*Mr. Samuelson.*) The Examinations of the Science and Art Department were established, were they not, in 1859 or 1860?—About that time, as well as I remember; but it was not till some time after that that the system had become so extended as to render it desirable for us to give up our exertions.

9010. Are you able to tell the Commission to what extent your examinations had been carried, at that period, with regard to the subjects which are now taken up by the Science and Art Department?—At that time, our total numbers were 800 in all subjects; when, however, we determined to omit the subjects taken up by the Science and Art Department, our totals were upwards of 2,000, of which 621 were in science subjects.

9011. Was the system, as established by the Society of Arts, spreading rapidly at the time when the Government stepped in?—Yes, but after all it was in a very small way; 2,100 was the largest number we ever had.

9012. So that you did not consider that the fact of your having attempted something of the kind was any reason at all why the Government of the country should not take the matter up?—It was our desire that the Government should do so. Our object was to set the matter afloat, and, if possible, get it taken up by the Government. That was our wish.

9013. You looked upon yourselves rather as pioneers than as a body permanently charged with a matter of that kind?—Decidedly.

9014. Knowing what you do of the action of the Science and Art Department, do you consider that, upon the whole, it has been beneficial?—Certainly, decidedly beneficial.

9015. It has carried out, with the power which the Government possesses, the system which you originated, and this was done with your approval and concurrence?—Yes.

9016. (*Professor Huxley.*) I suppose that, in practice, the Society of Arts could not have possibly borne the expense?—Certainly not. We never contemplated a continuance of it, but merely to set the thing afloat.

9017. (*Sir J. P. Kay-Shuttleworth.*) From the knowledge which you obtained of the condition of mechanics' institutions, even in the largest towns, at the time when the Society of Arts commenced its system in 1852, are you aware, and can you tell us, in which of those institutions there were successful science classes, aided by sufficient apparatus and by practical teaching?—As far as I can recollect, there was hardly one that had it. Huddersfield was one of the best in those days.

9018. Are you aware of the condition in which the Leeds, Manchester, and Liverpool mechanics' institutions were at that time, as respects practical teaching and the use of apparatus in scientific teaching?—There were classes, but little or no apparatus.

9019. Are you aware of the condition of the Liverpool Institution?—No, I am not.

9020. Would it be a correct description, so far as England is concerned, to say that in almost all the mechanics' institutions, even of great towns, scientific instruction was in a very undeveloped condition, and, particularly, that there was little opportunity for practical instruction in the use of instruments and of manipulation?—Certainly. I do not know any institution where they had it properly carried out, or where it could be said to be carried out at all.

9021. Are you aware of any institution in which the scientific teaching went beyond a limited course of lectures by a lecturer to an audience?—Yes, there were classes in several of the institutions where there was regular teaching.



9022. Could you name any?—Speaking now off-hand, I should say that there was in Leeds, and there was in Huddersfield, and in several other mechanics' institutions. I could not name them at this moment. I am speaking now of the period from 1856 to 1859.

9023. Does your memory serve you to say upon what subjects scientific instruction was given?—No, that I cannot say.

9024. Or the extent of the course?—No, except that it was small and superficial.

9025. Or the number attending the classes?—No, I have no information of that kind. We can only judge by the results of the examinations; we only know the number of candidates who came, and how they succeeded.

9026. Generally speaking, your impression is that such instruction, even in the best of those institutions, was in an undeveloped condition, and was imperfect?—Decidedly, very imperfect.

9027. So that they could not, at that time, be relied upon as centres of more advanced science, and particularly as centres of more advanced practical instruction?—Certainly not.

9028. Would you consider it a very sanguine expectation, now, that in some of those great towns with the aid of the government, and by the establishment of a system of inspection and proper rewards to the teachers, well-organized science classes could be founded in the mechanics' institutions, in which there should be that practical instruction with sufficient apparatus and sufficient opportunities for manipulation?—If you supplied them with the means of doing that, I have no doubt you could get a number of students to attend the classes.

9029. What expectation have you that there would be local subscriptions forthcoming to meet grants from the government?—I cannot say.

9030. (*Sir J. Lubbock.*) Do you consider that the condition of the pupils affords a good test of the efficiency of the school?—We did not examine schools at all.

9031. But you examined the pupils?—Yes, but not in schools; we examined the students in the classes, but they were all voluntary students, they were not like boys at a school.

9032. What I wish to ascertain is, whether you considered that in testing the qualifications of the students who came before you for examination, you obtained satisfactory evidence as to the efficiency of the school from which they were sent?—It gave us some clue to the efficiency of the teaching of the classes. But you must bear in mind that these were not schools, they were all of them voluntary classes, probably under voluntary teachers in many instances, in mechanics' institutions.

9033. But the working of those classes was to a certain extent tested by the result of your examinations?—We do not know, because we do not know the numbers of which those classes consist. We only know the individuals that come up to be examined. There might be a class of 50, of whom, perhaps, three would come up for examination, we did not know the proportion that those three would bear to the whole. We had no means of ascertaining what the efficiency of the teaching was, except as shown by those two or three picked individuals, who chose to come forward for examination voluntarily.

9034. So far as those individuals were concerned, it would be a test?—Yes, as far as the examinations could be a test of that which always depends upon the examiner, and how far he brings out the knowledge which the pupil has; but a good examiner might do so, certainly.

9035. Do you consider it would be necessary to lay down any restrictions as to the instructors who should be allowed to send up students for examination, or do you think that the fact of such students passing through an examination would be sufficient?—All who came up for our examination, I ought to have said, went through a preliminary test, first, before they were allowed to come to our examinations. They had

to be certified, either by examination or by some other means, that they were fit to come to our examinations.

9036. But you allowed any person to form a class and send his students up for examination?—Yes, provided they were connected with an institution in union with us.

9037. Would you consider it necessary, or not, that there should be any preliminary test of the qualifications of a master, or would you allow it to depend upon the power which he has shown of preparing his pupils?—I look upon it that there should be properly tested masters. I think that is a most essential thing for all classes.

9038. Then you do not think that the efficiency of the pupils whom he sends up would be in itself a sufficient test?—I do not think it would.

9039. Might I ask what you would consider to be a sufficient test of the efficiency of a master? what would you require before you allowed any schoolmaster or teacher to send pupils up for examination?—That is a broad question which I am not prepared, off-hand, to answer.

9040. You would not consider it desirable to allow any person to start science classes and send pupils up for examination?—No; I think teachers should, in some way or other, be tested as to their efficiency.

9041. But you are not prepared to express an opinion as to how the qualifications of teachers should be tested?—No.

9042. (*Chairman.*) Are there any other points which you would like to bring under the consideration of the Commission?—I may add this, that no one was allowed to come to our examinations who had not been previously tested as to his qualifications in the particular subject in which he wished to be examined; and, in addition to that, he must have been certified that he could read, write, and spell decently, and knew the first four rules of arithmetic, before he could have any chance of coming up. There were many persons who wanted to come up who could not write English, and could not spell, and yet, perhaps, they were very decent mathematicians; but our object was to encourage a certain amount of general culture.

9043. Had you any difficulty in providing sufficiently qualified examiners?—None at all.

9044. Was any remuneration for such examiners provided solely from the funds of the Society?—Yes.

9045. Do the operations of your Society bring you much into connexion with mechanics' institutes throughout the country generally?—Not much now-days, except upon the examination matters. There is a great change in those mechanics' institutes, altogether, from what they were when we first began. They were very little else than places of amusement in those days, then we got them to establish classes, but I do not think that has gone on progressing; I do not think there is much more doing now than there was 10 years ago.

9046. (*Mr. Samuelson.*) What is the meaning of mechanics' institutions being in union with the Society of Arts?—They joined us, and paid their two guineas a year, to assist in raising funds for carrying out those examinations, and other advantages which we give them.

9047. That is the only intercourse that you have with them?—That is so now. We had a good deal of intercourse with them, in the earlier days, when we assisted them in getting lecturers, and assisted them with information and advice, but latterly it has only been connected with the examinations.

9048. (*Sir J. Lubbock.*) Practically, all that you required was that students should come up from an institution that was paying two guineas a year?—Yes, subject to the preliminary test of the reading, writing, and arithmetic, and the special subjects they desired to be examined in.

9049. That did not in any way test the efficiency of the master?—No; we relied upon the local boards to certify to us that the student was a fit man to come up for examination.

*P. Le Nere  
Foster, Esq.*

13 June 1871.



*P. Le Neve  
Foster, Esq.*

13 June 1871.

9050. On the whole, you found that worked well and was a sufficient test?—Yes, quite a sufficient test.

9051. Do you see now any necessity to make the test more stringent?—The only stringency that we exert is continually enforcing upon the local boards that they should look more carefully into these matters, and that they should not send up candidates ill prepared.

9052. Is that with a view of relieving the exa-

The witness withdrew.

Adjourned to Friday next at half-past 11 o'clock.

miners from the labour of examining a number of persons not sufficiently trained?—Yes.

9053. (*Mr. Samuelson.*) But, you are not the administrators of certain public money?—No.

9054. (*Sir J. Lubbock.*) Still, you consider it a duty to apply the funds that you have entrusted to you to the best advantage, and, therefore, it would be the same whether it was public money or not?—Yes, just the same principle would apply.

6, Old Palace Yard, Westminster, Friday, 23rd June 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

The Most Hon. the MARQUIS OF LANSDOWNE.

Sir JOHN LUBBOCK, Bart., M.P., F.R.S.

Sir JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.

GEORGE GABRIEL STOKES, Esq., LL.D., Sec. R.S.

BERNHARD SAMUELSON, Esq., M.P.

WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.

*H. Cole, Esq.,  
C.B.*

23 June 1871.

HENRY COLE, Esq., C.B., further examined.

9055. (*Chairman.*) I believe you can furnish the Commission with some information as to the number of collections and museums of science and art supported by parliamentary votes?—Yes, I can enumerate to you those which are, at least, the principal, if not all. The British Museum, the National Gallery, the National Portrait Gallery, Greenwich Hospital Gallery, the South Kensington Museum, the School of Mines and Geological Museum, the Kew Museum, the Tower of London, and the Museum of Patents; also the Picture Galleries at Hampton Court, which differ in some respects from the other institutions, but are still supported by parliamentary funds; those are all in the metropolis. At Edinburgh, there is the Edinburgh Industrial Museum. Then there are several institutions connected with the Board of Manufactures, which, under an old treaty, has a fixed sum applied in part, I believe, to the National Gallery of Pictures there, and I think, also, to one or two other institutions. A Society of Antiquaries (I do not know its technical name exactly) receives aid, and there are the Botanic Gardens at Edinburgh, which are under the Office of Works. In Dublin, there is the National Gallery of Ireland for Pictures, there is the Royal Irish Academy, the Archæological Society; the Royal Dublin Society, and connected with that are the Museum of Natural History, the Glasnevin Botanic Gardens, and the Botanic Museum. Then there is an institution called the Royal Hibernian Academy, like the Royal Academy here in some respects, with the same aspirations of work; and the Zoological Society in Dublin. Those are the principal institutions which obtain grants annually from Parliament.

9056. Can you tell us how much public money is annually voted on the whole, and can you distinguish those collections which are more especially connected with art from those which are either mixed or connected with science mainly?—I could make some distinction, but without entering into that point, I take the British Museum as an instance. What your Grace would define, in short words, the British Museum to be, I do not know. By its old charter, it is a repository of things "rare and curious." That is what it is defined to be; and when the present Chancellor of the Exchequer moved a vote, as one of the Trustees, some four or five years ago, he defined it to be a collection of things "rare and curious." If you try and put the index to these words, I think one would say that the British Museum is a great library; whether you call it science or art, I leave your Grace to do as you please. Then, there are a great number of antiquities and the like. How much they are science and how much they are art, I do not pretend to determine.

And, besides, there is the Natural History Museum, which, I suppose, would be called specially science. Therefore, you see, it would be very difficult to define and attempt to say how much is science and how much is art in the principal museum, the place, in fact, which exhausts most of the public money. Then, if you take something that is purely scientific—such as the museum of Kew Gardens, not a great deal, but some portions, at least, of it, and some of the attractive portions of Kew Gardens would be looked upon as specimens of art. Again, if you take the Geological Museum, that, in the main, undoubtedly is a museum of science, but I suppose that the most attractive parts of it to the public at large, are the collections illustrating the history of English pottery and things of that kind, fine bronzes, and so on. I recollect Sir Roderick Murchison saying that he considered that the great malachite vase which the Emperor of Russia gave him was a union of science and art. It was beautiful in form, it was of a scientific material, and it is a good type of what is science and what is art, and, under certain circumstances, he intends to leave it to the nation. I only mention this to show that it is extremely difficult, in most museums, to determine precisely what is science and what is art, and any division about expense would be in the present state of matters I think nearly impracticable.

9057. You would not consider the National Gallery to be connected with science, in the ordinary sense of the term?—I should say it illustrates the science and principles of beauty. I should call it a kind of science. In answer, specifically, to your Grace's question about the sum of money voted for those various institutions, as well as I can make out from the estimates presented to Parliament this year, they amount to 235,600*l.* voted by Parliament for their maintenance.

9058. Do you know how much is voted for the British Museum?—The votes for this year are 97,969*l.*

9059. (*Professor Stokes.*) Is that sum which you mention exclusive of educational purposes?—That is the vote to the Trustees of the British Museum for the working of the British Museum.

9060. (*Chairman.*) In the vote for the School of Mines, for instance, are the salaries of the Professors included?—As far as they are included under the head of the School of Mines and the Geological Museum, they are.

9061. (*Dr. Sharpey.*) I suppose the library of the British Museum is included under that amount?—Yes, everything.

9062. (*Chairman.*) Do you know how much of that 235,600*l.* is spent in London, or in the neighbourhood



of London, and how much in Edinburgh and in Dublin?—About 209,400*l.* in London, 10,900*l.* in Edinburgh, and 12,470*l.* in Dublin.

9063. Can you describe to us the administration of those collections?—I cannot describe it with brevity, because it is so extremely varied. I must go through each one, I believe. The British Museum is governed by Trustees, about 45 in number, of whom the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons are the chief. The National Gallery is also governed by Trustees. The National Gallery, which is a large institution, is governed by few trustees, and the National Portrait Institution, which is a small institution, is governed by a large body of Trustees. Greenwich Hospital Gallery is under the Lords of the Admiralty. The South Kensington Museum has one head, and in his absence another head, and, therefore, it has what Jeremy Bentham would have called a single-seated responsibility. The School of Mines, and the Geological Museum, are under the same parliamentary head. The picture galleries at Hampton Court, in so far as Parliament is concerned with it, are under the Office of Works; but in respect to the property of the pictures they are under the Lord Chamberlain. Kew Gardens is under the Chief Commissioner of Works. The Museum of Patents is under the Commissioners of Patents, Lawyers. The Edinburgh Industrial Museum is under the Lord President. The National Gallery at Edinburgh is under the Board of Manufactures, which is a trust. The National Gallery of Ireland is also under Trustees and a Board. The Royal Irish Academy is under a Board. The Royal Dublin Society is under a numerous Board. The Dublin Botanic Gardens are under the same. The Museum of Natural History is under the same. The Library at Dublin is under the same. The Royal Hibernian Academy is under a Board of Academicians; and the Dublin Zoological Society is under a Board. The result is, that the responsibility is very different with each of those institutions.

9064. Are all of them, more or less, responsible to Parliament?—I should say that in one sense few are directly responsible to Parliament. The British Museum is not directly responsible to Parliament at all. Sometimes Mr. Walpole moves the estimates, if he be in opposition, and if Mr. Lowe be in opposition, he moves the estimates. But who is the paid parliamentary officer that is responsible for the proper administration of the British Museum has yet to be discovered. The National Gallery is also like the British Museum; so far as there is a Parliamentary responsibility, it is under the Treasury, but, as I understand the British Constitution, the Treasury has to control the expenditure and not make it. I believe lately the Treasury bought the Peel Collection directly, a very right thing, I daresay, to do, and I daresay the Treasury were well advised, but it seems something like superseding the Trustees. I do not mean at all that the Trustees did not agree in it, but the case bears a sort of divided responsibility. Then the Museum of Patents has no parliamentary responsibility at all. The Royal Dublin Society has a kind of mixed responsibility; if something happens that the Lord President thinks very bad, he stops it; otherwise, the society goes on by its own movement and its own Trustees. The Royal Irish Academy has no parliamentary responsibility, excepting that responsibility which is said to belong to the Treasury. The Treasury is not the administrative body in respect of the Royal Irish Academy, which looks after the funds; so that, in fact, the bulk are all, according to my view, irresponsible; that is to say, there is no direct responsibility. I find that I am agreeing with what the late Chancellor of the Exchequer said years ago, in 1860. On moving the Civil Service estimates it was objected by Mr. Ayrton that, as respects the British Museum and other institutions or museums and collections of different kinds, they were not under one directing hand; they were all placed under separate Trustees and Managers, and, hence, there was no unity in their management. In answer to that, the Chancellor the Exchequer, Mr. Gladstone, said, with reference to

that point, as well as the management of public buildings, that "he had no hesitation in saying that this defect and other circumstances of a like kind were entirely owing to the lamentable and deplorable state of our whole arrangements with regard to the management of our public works. Vaccination, uncertainty, costliness, extravagance, meanness, and all the conflicting vices that could be enumerated were united in our present system. There was a total want of authority to direct and guide. When anything was to be done they had to go from department to department, from the Executive to the House of Commons, from the House of Commons to a Committee, from a Committee to a Commission, and from a Commission back to a Committee, so that years passed away and the public were disappointed, and the public money was wasted. He believed that such were the evils of the system that nothing short of a revolutionary reform would ever be sufficient to rectify it." As far as I see, the facts remain precisely the same as they did when they were thus described in August 1860.

9065. Do you agree with Mr. Gladstone, as to the extent of the evil resulting from the present system, or want of system?—Entirely.

9066. Is it the fact that in different places the same classes of objects are under different managements?—Yes, and it almost assumes an appearance of humour. There are portraits of eminent national persons, being public property, in the charge of the Trustees of the British Museum, of the Trustees of the National Gallery, of the Trustees of the National Portrait Gallery, of the Lords of the Admiralty at Greenwich, of the Commissioners of Public Works, besides the Crown property at Hampton Court and Holyrood Palaces. As respects pictures and sculpture, they are in the charge of the Trustees of the National Gallery, the Trustees of the British Museum, the Lord President at Kensington, in Hampton Court Palace of the Commissioner of Works, and the Lords of the Admiralty at the Greenwich Hospital, &c. And then, if you take drawings, they are in the charge of the Trustees of the British Museum, of the Lord President at South Kensington, of the Trustees of the National Gallery, and so on. Then, as respects the general fine arts, not pictures or sculpture specifically, they are in the charge of the Lord President at South Kensington and of the Trustees of the British Museum. Then botanical specimens are in charge at Kew, at the British Museum, and at South Kensington. The collections of mineralogy and geology are at the British Museum and at the Geological Museum. The collections of natural history are at the British Museum and at the South Kensington Museum. Collections of models of nautical science are at South Kensington, in the charge of the Lord President, the Lords of the Admiralty, and the Commissioner of Patents. If you wish to have one of the most laughable instances of the same kind of thing, that is almost the same thing being in different charges, you have Leslie's picture of "My uncle Toby and widow Wadman." You have a picture of which the painter made three copies, one of which is in the National Gallery at Charing Cross, one in charge of the Lord President at Kensington in one part of the building, and one in charge of the Trustees of the National Gallery in another part of the building.

9067. Can you give the Commission any information as to the cost of management in those different collections?—In the year 1860, Mr. Lowe was Chairman of a Committee, on which I was examined as a witness, and I was asked to try and find out the cost of management of those various institutions. I took the British Museum and the Kensington Museum, and, by way of comparison, the Crystal Palace, which being a commercial enterprise, was a sort of test of the cost of management, as far as I could get a test. Of course, the votes give the total cost of management, but there is a great difficulty about establishing an accurate comparison. There are a multiplicity of circumstances, which make some appear to be costly, and others not so. But, taking a rude measure of cost, that is to say, the cost per visitor, the facts in 1860 were these—that, as respects

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23 June 1871.



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payment in salaries, every visitor who went to the British Museum, cost 1s. 1½d. I find that it is now 1s. 9¾d. Every visitor, in respect of purchases at the British Museum in 1860, cost 1s. 1d.; it now costs 10½d. The total cost at the British Museum, dividing the whole expenses over the visitors, in 1860, was 3s. 2d.; that is to say, every visitor cost 3s. 2d., and he now costs 3s. 8d. If you compare that with Kensington, the facts are these—in 1860 every visitor, in salaries, cost 4d.; at the Crystal Palace he cost 4½d. Every visitor, in respect of purchases, cost 5¾d.; and in respect of the total expense, he cost 1s. 3¾d. Taking the numbers in the estimates of last year, he now costs, in respect of wages and salaries, 6½d.; and, in respect of purchases, 5d., rather less than what he did in 1860; and the total cost of him, altogether, is 1s. 3d., as against 3s. 8d. at the British Museum. As regards the Crystal Palace, at the present time, I have not worked out the figures, but I believe that they are very nearly about the same as what they were in 1860. In 1860 the total cost at the Crystal Palace was 1s. 3¼d., as against 1s. 3¾d. at Kensington, and 3s. 2d. at the British Museum. There is a curious kind of tradition going on in institutions for counting people going into the institutions. The Crystal Palace and other modern institutions use turnstiles. You can buy a very good turnstile for 15l., and, perhaps, it costs 2l. or 3l. a year to keep in order; and it counts precisely. The public go in, and they are counted without anybody to attend to it. We use a turnstile at Kensington, but at other of the great institutions they use policemen or attendants to stand and count. A policeman costs 70l. a year

to begin with; I defy any policeman to count as accurately as a turnstile, and the result of my observations is, that the numbers in many of those institutions are quite impossible, considering their size and capacity for accommodating them. That is a kind of incident of management, which, if there were due Parliamentary responsibility, I think, would be cured in a very short time, especially as Parliament constantly calls for returns of numbers.

9068. (*Marquis of Lansdowne.*) Is the policeman put there only to count?—I have been so informed, and that he is considered as accurate as a turnstile; but experience would lead me to think that it is quite impossible that he can count accurately. Certainly he cannot count accurately and watch properly at the same moment. A man counting 10,000 visitors, going on all day, is a very imperfect instrument, I think.

9069. (*Professor Huxley.*) Is it the same policeman who stands there all day long?—I think so.

9070. (*Mr. Samuelson.*) Is there not an attendant at the turnstile at South Kensington the whole time?—There is an attendant to take the money, but I am making a comparison now between a turnstile and a policeman or attendant as instruments. Of course, you have to pay for the police administration in both cases.

9071. (*Chairman.*) Can you give us any information about the cost of management in any of the other institutions?—I could work out, if the Commission desired it, the cost of management by the number of visitors.

9072. Is Kew very costly in proportion to the number of visitors?—I should say not.

COMPARATIVE STATEMENT of the Working Expenses of various Public Museums, &c., giving the Cost per Visitor for the Year 1870.

	Salaries, Wages, and Police.			Purchase of Specimens.		Other Expenses.		Total.	
	Sum voted.	Per Visitor.		Sum voted.	Per Visitor.	Sum voted.	Per Visitor.	Sum voted.	Per Visitor.
	£	s. d.		£	s. d.	£	s. d.	£	s. d.
*South Kensington Museum - - -	27,574	0 6½		21,250	0 5	15,040	0 3½	63,864	1 3
British Museum - - -	50,875	0 9¾		24,190	0 10½	28,044	0 11¾	103,109	3 8
National Gallery - - -	4,216	0 1½		10,000	0 2½	2,350	0 0½	16,566	0 4½
†National Portrait Gallery - - -	772	0 3		910	0 3¾	571	0 2½	2,253	0 9
Kew Botanical Gardens - - -	4,695	0 2		—	—	1,7806	0 7½	22,501	0 9½
Edinburgh Museum of Science and Art - -	2,729	0 2½		2,350	0 2	3,395	0 2¾	8,474	0 7
National Gallery—Ireland - - -	836	0 1¾		600	0 1	957	0 2	2,393	0 4¾
Dublin Natural History Museum - - -	1,015	0 2½		600	0 1½	1,445	0 3	3,060	0 7
Glasnevin Botanical Gardens - - -	1,446	0 1½		—	—	1,418	0 1½	2,864	0 3

\* The cost of the South Kensington Museum includes that of purchasing and circulating objects to local museums, Schools of Art, &c., throughout the kingdom.

† The National Portrait Gallery was not opened to the Public in the new rooms until the 28th March. The number of visitors for the rest of the year was 58,913, against an average of about 25,000 in the previous three years.

9073. Can you give us any other instances of specific evils arising, in your opinion, from the want of management?—There are the same kinds of things under different managements, and the consolidation of the same things under any system is impossible unless Parliament constitutes a sufficient authority. It is notorious that every institution looks upon its neighbour very much askance. Institutions never get on well in concert. The two most jealous things in the world are two different public institutions, and if they happen to be doing nearly the same kind of work, the jealousy is rather intensified, and nothing but a responsible despotic power can put things right, as Mr. Gladstone pointed out. In my opinion, there is a crying grievance now, but I do not see how it is to be remedied without Parliament intervening. Mr. Sheepshanks, about 13 years ago, gave to the nation a collection of pictures worth at that time 60,000l., and now worth, I daresay, nearly 100,000l., upon the clear understanding that it should be the nucleus of a collection of British art. To this day, nothing has been done to realise his intention, and I am not sure that Cambridge

might not move the Court of Chancery to transfer the pictures to Cambridge as a breach of the contract. The National Gallery has British pictures and buys British pictures; but there is no limit of division even in saying that the old ones shall be at the National Gallery and the new ones at Mr. Sheepshanks' gallery. If there were a Minister responsible to Parliament, the thing would be put right in a very short time. Instead of exhibiting two pictures of the same kind within the same walls at Kensington, one would be exhibited, and the other would probably go to a local museum or be circulated about. I consider the nation has broken faith with Mr. Sheepshanks, and it is all owing to the want of a proper responsible administration. Touching another point, the superfluities of objects, the British Museum has its walls nearly bursting for want of room, and yet there are heaps of objects that I think could, with the greatest benefit to all parties, the country at large, as well as the museum itself, be taken away and distributed; but you cannot touch them. It is one of the most holy things in the world is an object in the British Museum; it is so sacred that you cannot make



any change at all. Kensington has given the British Museum objects, and we have made one or two attempts sometimes to get an object in return. I have in my mind, now, an Indian object. The proprietor gave the British Museum a carved Indian object, years ago, and if his story be correct, and I have no reason to doubt it, it has been hidden in cellars ever since. Of course, he is not best pleased about it, and he has written to us to ask if we could not have it up out of the cellars and exhibit it with our other Indian objects. We applied to the British Museum, but talk goes on, year after year, and we are not a bit further advanced. The public do not see it in a right place, and the proprietor does not have the gratification of seeing it properly exhibited, and it will be so to the end of time, I suppose.

9074. In your judgment, are there numerous instances of superfluity at the British Museum?—I have no doubt, myself, that there are a great number of objects in the British Museum which are superfluous. If anybody will go through the archaeological collections of Egypt there, he will find heaps and heaps of almost the like kind of things. There again it has been a matter of talk, always talk, of handing the superfluities over to us to circulate, but we have never advanced a bit. That very point of handing over superfluous Egyptian antiquities which crowd up the cupboards in the British Museum has been talked over for the last seven years, but no result has been attained, and during all this time the local museums of the country are hungrily crying out for more specimens. I know of another case, nearly connected with Kensington, and that is the National Gallery of Pictures. I do not hesitate to say that half the collection belonging to the public in the National Gallery could with very great advantage be circulated all over the country, rather than kept in London, and I say that in the most emphatic way.

9075. We have had before us some of the officers of the British Museum, and I think the tendency of their evidence has been that, as far as the natural history collections are concerned, there is no great number of duplicates or of superfluities; do you agree with that statement?—I am unable to pass an opinion upon that. The natural tendency of all museums, not only of public collections, but of private collections, is to become overcrowded. I should say, generally, that is the case, and in proportion as they get overcrowded they become neglected, and the objects become dirty, and dusty, unseen, and imperfectly seen. There can be no doubt that anybody who looks at the cases of natural history in the British Museum would say that if they were properly exhibited they would occupy five times the space that they do now. They are huddled together like sheep in a pen, in many cases.

9076. Have you much acquaintance with the principal local museums?—I know many of them, but not with great accuracy. There is a very increasing demand from all kinds of institutions throughout the country to the Kensington Museum to send specimens to them, and we have a very considerable constituency. Last year more than 800,000 people, in the different localities, inspected objects which had been sent from the Kensington Museum in circulation. Since 1854 138 exhibitions have been aided, which have been visited by 3,073,096 persons. These results do not include the Art Treasures Exhibitions at Manchester and Leeds, and the Dublin Exhibition of 1865. Besides, the art schools have borrowed paintings and objects of all kinds for study; 2,126 objects of industrial art, and 1,067 reproductions have been collected together for circulation. Examples from the educational collections and illustrations of the Food Museum and of Botanical preparations have been circulated.

9077. Do you think that much more might be done in the way of circulating from London to local institutions?—Yes, a great deal, and with great advantage to all parties. I believe it would be a great advantage to the collections in London, and very acceptable to the country at large.

9078. Would you recommend that in any instances duplicates or superfluities should be actually made a

present of to local institutions?—I think that generally presents are not advisable. I think that it is far better for a locality to have a rotation of things, particularly works of art, rather than to have a second rate, or third rate, collection permanently deposited. The neighbourhood gets tired of them and they cease to go, whereas, if you have something like a different collection going on at different times, say, lasting for one twelvemonth, and then another collection to follow, you excite a great deal more interest. With respect, of course, to scientific collections, collections of natural history, they are not such fit objects for circulating as objects of art would be. There ought to be type collections of these scientific objects. But as to anything that is interesting and instructive in art, and that can be moved about, it ought to be moved about, and I think that circulating is a much better principle than depositing in this case.

9079. Are there any fixed regulations under which the circulation from the South Kensington Museum is conducted?—Yes.

9080. And the period during which the articles are deposited elsewhere?—There are some general rules: sometimes they are a little modified: as, for instance, we do not hesitate for a very short period, indeed, to send the most precious objects in Kensington for a particular purpose. I call to mind that, on one or two occasions at Sheffield, some of the most valuable examples of metallic work which the Museum possesses have been sent down there for two or three days. We have, as I have said, a considerable number of objects which have been put aside expressly for circulation. If the Commission cared to look through the galleries at Kensington, they would find a part of the Museum where the cases are filled with objects expressly to be circulated, as they are required by localities.

9081. Do you have numerous applications for loans?—Yes. We make a return to Parliament every year, and you will find in the last annual Report the details of the places which have received objects, and the number of persons who have visited them, and they are more or less full always. At pages 354 &c., of the 17th Report of the Science and Art Department, and at the following pages, you will find an enumeration of the numbers of things, and a list of the different places which have received objects from Kensington during the past year.

9082. Has South Kensington greater facilities for managing a system of circulation than any other of the institutions to which you have referred?—South Kensington has matured a system more or less; it has special vans; it has found out, by experience, how to do the work cheaply, how to interest the localities, and how to induce them to pay a certain part of the expenses. For instance, at one time we paid the railway expenses of those vans, but we found that the railway companies did not hesitate to put the highest possible charge upon Kensington for carrying those vans. We then discovered that if, instead of our making the bargain with the railway companies, we put it on the locality to make the bargain and only to pay them half, they got up a little wholesome competition between the various railway companies in their neighbourhood, and our cost has been reduced two thirds. We have, I think, devised a system which fairly answers its purpose, and, like most systems, it may be improved from time to time; but I think that the Lord President's administration is sufficiently organized fairly to respond to the wishes of the country, and does so. We have the advantage of space, which is a large element in administering things of that kind; and we have got a pretty fair system of taking things in and giving them out again, and checking them, and we have had scarcely any accidents worth naming.

9083. Under the existing system, do you think it could be practicable to carry out the practice of circulating articles to a greater extent than at present?—Utterly impossible, until you give the Lord President power. We have made two or three attempts to get superfluous pictures from the National Gallery, and, after years of correspondence, we get, perhaps,

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23 June 1871.



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three or four pictures, while there remain scores and hundreds that could be well used. In fact, the dead lock takes the heart out of anybody who wishes to see objects circulated.

9084. (*Mr. Samuelson.*) Have you circulated any of the Sheepshanks' collection?—Yes, many. Mr. Sheepshanks provided, in his deed of trust, that the schools of art throughout the country should have the right of borrowing his pictures under proper rules.

9085. (*Professor Huxley.*) The pictures at Dulwich used to be lent out, did they not?—They used to lend them to the Royal Academy.

9086. I think that was the first case of the kind?—I suppose, perhaps, an earlier case than that was the loan of pictures from private collectors to the British Institution in Pall Mall. I think that was earlier than Dulwich College, but it is half a century ago. There has always been a desire on the part of possessors of pictures to be liberal in allowing them to be seen, and, until lately, that was manifested chiefly through the British Institution. The British Institution now no longer existing, pictures are lent to the Royal Academy, and over-abundantly lent to Kensington. It is quite curious to see the pleasure and interest of people to lend things to Kensington. Without mentioning the collection, I think we have property lent us by one gentleman positively of the value of a quarter of a million, and we have had possession of it for the last eight years, and the public have almost as much advantage out of it as they would, if it were their own property. It is very much the custom now, if a gentleman is going to repair his house and remove his collection of pictures, for him to send us word and ask whether it would gratify the public to have a view of them. Lord Westminster last year allowed Kensington Museum to take in as many as its crowded state would allow, and Lord Elcho did the same. Mr. Munroe's collection of pictures is now in South Kensington Museum, and in some cases the proprietors give us the freedom to circulate them to the country; but as to the kindly liberality that is going on, it is gratifying to see how it is developing.

9087. (*Professor Huxley.*) Not merely with regard to paintings?—No, not at all.

9088. (*Chairman.*) Are you prepared with any suggestion as to the introduction of an improved system of management applicable generally to the national collections?—I think that the crux of the whole business is to have a single responsibility to Parliament. If there were a Minister in Parliament, who, in respect of the administration of the public money for all those collections, was able to answer questions, the whole thing would be improved instantly. I have not the least doubt about that, and short of that I do not believe improvement ever will take place. What can be done to move 45 illustrious gentlemen who are unpaid? If the public money is to be spent, I think that there should be Parliamentary responsibility.

9089. How would you propose to carry on the management under this Minister?—I think there would be no difficulty in that. I am not so revolutionary as to wish to take away any proper functions from Trustees; on the contrary, I think they might be very usefully employed. Their functions might remain to inspect and to suggest, and to find fault, but I do not suppose that anybody now-a-days would ever contemplate spending 100,000*l.* a year of the public money by the management of a Board of 45 gentlemen. I do not think that any commercial business in the world could ever be managed upon that principle. The Trustees of the British Museum, of course, might remain, and they would have all their authority that they have now, short of the administration of the public money; that is to say, they would see that the objects of which they were the Trustees were properly taken care of. Their trusteeship is, after all, a somewhat mythical affair, but still it might remain, and I would not abolish it. That kind of Parliamentary responsibility, again, has been proposed for the last 25 years. Mr. Hawes,

afterwards Sir Benjamin Hawes, had a Committee 40 years ago, in which the identical thing was proposed, but nothing came out of it. Then Lord Langdale took the question up, and he saw exactly the same point, and wrote a most strong remonstrance against the present system, and there it is. What only remains are his words.

9090. (*Professor Huxley.*) That proposition would rather relegate the Trustees to the category of rare and curious objects, would it not?—Perhaps it would. In making these profane observations against Trustees, my opinion is, that it would not be expedient to abolish them. I think it is very desirable that all classes, and the higher classes particularly, should be interested in these things; and I would not by any means cut them adrift from taking an interest in them; but, as business managers, I do not think any person having to spend 100,000*l.* would put it into the administration of unpaid irresponsible parties. Such evils as Mr. Gladstone has described, I think, result from that want of responsibility and proper administration. But I think that something that would be acceptable to the Trustees, as well as very good for the promotion of science and art, could be devised for the benefit of all parties. I think that if different persons of station and rank, and men of science and art, were constituted Honorary Inspectors of our public collections, and had, perhaps, the responsibility of making only a report once a year from an inspectorial point of view, great advantage would result. They might be Privy Councillors for Science and Art, to be summoned as the Lord President of the Council thought fit. I speak with confidence upon that point, because, on several occasions, when Kensington has attempted to make collections, and has thought that it would promote the making of collections to have men of rank and station connected with it, we have had no difficulty whatever; and it has been rather a satisfaction and pleasure, as far as I have observed, to noblemen and others, to form a Commission and to take all the work, short of what you would call administrative drudgery; that is, to advise and control and assist, but not doing the actual administrative work. And I think that something might be devised with great advantage to the public, superseding the present system of Trustees. I can have no doubt at all that, instead of keeping up all those different Trustees, which have arisen very much by hap-hazard in different places, a good would result even from uniting them. I cannot see any sense in having Trustees of national portraits in one place under one set of Trustees, and other Trustees holding national portraits in another institution, and Trustees of national pictures of another kind, all the things scattered about with differences of management, and that management none of the best description.

9091. (*Chairman.*) South Kensington is more directly under the management of the President of the Council, is it not, than any other Department?—Yes, in the most direct way possible. If anything goes wrong, the Lord President or the Vice-President can instantly be called to account in Parliament for it; and if his officers do not do what they ought to do, they can just be sent about their business.

9092. (*Professor Huxley.*) You do not propose to construct any body of Trustees at South Kensington, to perform the functions which you have described to us?—There are no Trustees, but constantly professional advisers. If the Lord President wishes to have a certain piece of work done, his executive officers are not supposed to be omniscient, and he does not believe them to be so, but he gets all kinds of outside assistance from men of science, and others, and we have not the least difficulty, as I mentioned. Take the case of the National Portrait Collection. Lord Derby, I recollect, recommended a national portrait collection to be made, that went on for three years; in order to get the good will of the possessors, and to keep the thing on, a very large Commission was formed for that purpose *ad hoc*, and they worked most successfully and accomplished the work.

9093. But the ordinary administration of the museum goes on very well without Trustees, does it not?—Yes,



We did not begin with Trustees, and I know that the insertion of them would not be good, but I should see no reason why the Kensington Museum should not be part of a general system where there should be Trustees with a single Parliamentary head; on the contrary, I see rather an advantage in that. If you ask me whether Trustees should be created especially for South Kensington independently, I say no, but as part of a general system of inspection, yes.

9094. But supposing that the Natural History Museum is sent to South Kensington, it would have to be on an entirely different footing from what it was before?—In a different place.

9095. But supposing it should be on a different footing in the other sense, do you see any great necessity for connecting a Board of Trustees with it; do not you think it might contrive to work as well as Kensington does now, with the direct responsibility of the Minister?—Yes. There is this speck of difference about it. You are supposed to have at the British Museum the Sloane collection of natural history, and Trustees have been appointed for the Sloane collection. If you say that you intend to send them to the right about, and see no good in them, of course I cannot say more, but I do not know whether Parliament would like it or whether they would not like it: but I see no reason in the world why the Sloane Trustees should spend 50,000*l.* a year for supporting a museum that is no part of the original trust, or no part of the original agreement. I would certainly conserve them to look after the remainder of the Sloane property, if they like it. I should not put the public money into their hands.

9096. You would confine their inspection to the Sloane property?—Yes, and take their advice on other subjects.

9097. (Chairman.) The Trustees which you have no objection to see continued, you would look upon rather as a general advising and consultative body?—Yes, and I am quite sure that advantages would arise from that. Perhaps that remark applies less to natural history which makes itself. It is not like collections of what are called *objets d'art et vertu*, and things of that kind: but I am quite sure that if the supreme Parliamentary authority had the power of consulting gentlemen who took an interest in those subjects, it would be advantageous. Of course, the responsibility rests with him whether he would adopt their advice or not. He must have professional advice, in any case, but I think there are advantages in having the assistance of gentlemen who spend their own money in those things. There is an obvious advantage which we find at Kensington, that if you interest people in the place, they give you gifts and make bequests, and that is a great advantage to the public. Somebody makes a good collection; he cannot carry it out of the world with him, and then he leaves it to his countrymen.

9098. The estimates for South Kensington and the Kew Botanic Gardens, and possibly for some of the other institutions of which you have been speaking, are prepared, are they not, under Government authority?—Yes.

9099. With the exception of the British Museum, is there any large spending institution for which the estimates are beyond the control of Parliament, at least, so far as their preparation is concerned?—The estimates of the British Museum are prepared by the Trustees. They make a petition to Parliament every year for money to carry on their operations, and I suppose the Treasury gives them an answer to say that their petition will be listened to; at all events, the petition is always presented, and their estimates are prepared by the Trustees, I believe in concert with the Chief Librarian; they are then submitted to the Treasury, who approve, or otherwise, the estimates so submitted, and, therefore, to that extent there is obviously some kind of responsible interference in the preparation. The same thing happens, I believe, with the National Gallery, as I mentioned. Occasionally, I believe, the Treasury itself becomes the actual pur-

chasers, that is to say, in a direct way they become the purchasers of pictures; and the National Portrait Gallery goes on in the same way. As to the Greenwich Hospital Gallery, I do not know exactly how that is managed. The South Kensington Museum is under the Lord President absolutely, also the School of Mines, and the Geological Museum; the Queen's pictures at Hampton Court are under a divided authority; the Office of Works takes a sum of money for the repair, and the votes pay for the police and attendants. Kew Gardens estimates are also prepared under the First Commissioner. The Museum of Patents is a curious thing; it was started by the Commissioners of Patents; the fees of patentees are taxed to support the Museum of Patents, and a large revenue is derived from their fees, which goes into the general taxation purse, and the Commissioners of Patents are the supreme body over the Patent Museum, subject, of course, to the Treasury approving their estimates. If I wanted to point to the Committee where a thing is as dead as a door nail, in my opinion, it would be the Museum of Patents being thus under a body of Commissioners. It was a very curious idea to start with; it was intended to be something of an imitation of the *Conservatoire des Arts et Métiers* in Paris, but it is as different from that as chalk is from cheese. It is called the Patent Museum, because the fees of patentees were to pay for it, and pay for the new building, and now it is supported by the direct vote of Parliament. As this is especially a scientific institution, I would venture to put before the Commission some account of what the *Conservatoire des Arts et Métiers* is, which I think seems to point to what the Patent Museum may be at some time or another. Years ago, the Lord President of the day desired Captain Fowke and myself to go to Paris and to find out how far the *Conservatoire des Arts et Métiers* was connected with the French patent system. Captain Fowke and myself went into the subject, and I believe exhausted what knowledge could be got from it, and, with your permission, I would like to put in our Report, because I think it bears more directly upon the Science Commission than perhaps any other point, excepting the Natural History of the British Museum, and it is as follows:

#### REPORT ON THE CONSERVATOIRE DES ARTS ET MÉTIERS AND BREVETS D'INVENTION.

South Kensington Museum, January 1865.

To the Lord President of the Council.

MY LORD,

IN obedience to your Lordship's instructions that we should proceed to Paris and examine into the relations which exist between the *Conservatoire des Arts et Métiers* and system of French patents, we have prepared, and have now the honour of submitting, the following Report:—

1. The *Conservatoire*, of late years, under the able direction of General Morin and M. Tresca, has become one of the most popular institutions in Paris.
2. This establishment, first created in 1788, has passed through many phases of constitution and management. At the present time, it has three predominant features: (a), the public exhibition of machinery, manufactures, and models of an industrial and scientific nature; (b), a scientific library, open gratuitously to all; and (c), courses of gratuitous lectures, given during the autumn and winter in the evening, by the most eminent professors in France. These lectures are attended by several hundred persons. A prospectus of the courses for the present session is appended (page 280). [See Report.]
3. Besides these three features, the *Conservatoire* is the repository for the brevets d'inventions and the models deposited with them, which have exceeded the age of 15 years from the first issue of them. This connexion of the institution with extinct brevets d'invention is a subordinate feature to its chief operations.
4. The *Conservatoire* consists of a series of ancient and modern buildings: the ancient, belonging to the Abbey of St. Martin des Champs, date from A.D. 1860, and are highly interesting to the archæologist. They have been well adapted to the purposes of the establishment, especially the old refectory, now converted into the library.
5. The principal façade is now opened to the new Boulevard de Sébastopol, fronting a large square. Additional parts of the old monastic buildings of the Convent of St.

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23 June 1871.



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Martin are being restored and brought into use, whilst new buildings are being constructed to afford additional space. The ground already occupied by the establishment is 5·178 acres (or 20,956 mètres carrés), and this is being extended to 6·558 acres, or 26,540 mètres carrés de terrain. The buildings themselves occupy, at present, 8,383 mètres carrés, or 10,026·346 square yards, which will be enlarged to 16,744·565 square yards.

6. The laying out of the ground, and the divisions into which the collection is arranged, are shown by the accompanying plan (App. C). [See Report.]

7. The divisions are: machinery in motion, hydraulics in motion, agricultural implements, locomotives, horology, building models, &c.

8. These plans show the position of the two chambers, the lower of which contains the specifications of brevets d'invention, whilst the upper contains the models. These chambers are on the opposite side of the court to the library, and have no connexion with it. These rooms are about 60 feet long by 20 feet wide. The contents are very miscellaneous, and covered with dust: such as old hats, and woven fabrics, traps, tin ware, surgical appliances, and broken wooden models. It is not surprising that they are not considered of sufficient value or public interest to be kept with the general collection. They are never consulted. M. Tresca, the sous-directeur, has kindly answered some questions which we put to him. (See page 287.) He shows that they do not influence the extent of the general collection of machinery, &c., and their value to it is explained to be nothing.

9. On Thursdays and Sundays the galleries are open free, and are crowded. On other days, reserved for students, the principle of admitting the public by a moderate charge, as at South Kensington, has been adopted, and visitors pay one franc each.

10. Four separate authorities throughout France are concerned in the issues and searches of brevets d'invention :—

- a. The Ministry of Finance.
- b. The Ministry of Agriculture and Commerce.
- c. The Prefecture of the Department.
- d. The Conservatoire.

The necessary instructions, &c., for obtaining a brevet are given in a paper appended (page 282). It will be observed that the instructions make no mention of models as any part of a brevet d'invention, and, as M. Tresca shows, they are of no value whatever.

11. In Paris all brevets d'invention are kept and registered. Those under 15 years of age are preserved in the Rue de Varennes, on the south side of the Seine; those above that age in the Conservatoire des Arts et Métiers on the north side, about two miles apart.

12. The steps necessary to be taken in Paris for obtaining a brevet d'invention are as follows: The applicant for a patent must first apply to No. 24, Rue de Mont Thabor. This is a subordinate bureau of the Ministère des Finances, not very readily found or publicly indicated. He passes through a gateway between the Cafés des Finance and a stable for remises. He ascends to the second stage up narrow stairs, dark and odorous. Here is the bureau for the first stage of proceeding. He pays 5 francs, and obtains the necessary forms to be filled up; fills them up and pays 100 francs, 4l.

13. These forms being filled up, he takes them with the receipt to the Hotel de Ville, and there he deposits his specification.

14. This specification is sent to a third bureau, which is on the opposite side of the Seine, No. 78, Rue de Varennes, the Ministère de l'Agriculture et du Commerce, and is also up two pairs of narrow dark stairs. Here the specifications are kept during 15 years, whilst the patent lasts; after that period they are transferred, with any models accidentally accompanying them, to the Conservatoire des Arts et Métiers.

The room for searches is about 60 feet long and 16 feet wide. The specifications are arranged in carton boxes on shelves. It is rather crowded. Anyone enters and searches in the printed catalogues, and calls for the brevet without let or hindrance; but he is not permitted to make notes even in pencil. Copies must be ordered of the office at a given tariff, and if a copy of a drawing is required he must bring his own draughtsman.

15. The catalogue of the specifications is printed, and may be bought at V. Bouchard Huzard, Rue d'Eperon, No. 5.

16. It has been already pointed out that the law does not require that any models should be made, but some are sent. The officers kindly showed us what they possessed. We were conducted up back stairs into a little room about 10 feet wide by 20 feet long. The floor was covered with

models unarranged and very dusty. On a shelf were some models in tin, also very dusty. A model of a shoe was here, a candlestick there, &c. The officer said that they were very rarely looked at, and the accuracy of the statement was fully borne out by the condition of the room. He said that all the models in this small chamber were the products of some 20 years.

17. These facts show that the Conservatoire des Arts et Métiers did not arise, and is not at all dependent on any connexion with models accidentally delivered with the brevets d'invention, which are not recognised by the French law. The Conservatoire is a great educational institution, teaching the general public through its exhibitions, and a special public through its lectures. It seems to us to afford an example which our own country might imitate with advantage generally as to scope, and also in many of its details.

We have, &c.

(Signed) HENRY COLE.

FRANCIS FOWKE,

Captain R.E.

9100. (Marquis of Lansdowne.) You have spoken at some length as to the disadvantages of the system of Boards of Trustees. I should like to ask you whether you contemplate dispensing altogether with that system, or whether a modified form of it would not be, at all events in the case of some institutions, indispensable. I am speaking now not so much of that purely honorary office of Trustee which you have described, but of a Body of Trustees coming between the responsible Head of the Department and the public?—If I understand the distinction that your Lordship would make, you would point to some cases where the intervention of other authority, being a Body of Commissioners or Trustees, would be desirable. I have no objection to that, provided you do not give them the charge of the public money, which is the whole gist of the business, I think. Take the very simplest case that presents itself to me. Mr. Sheepshanks gave his pictures to the nation upon conditions. He looked upon the Lord President as an *ex officio* Trustee, but he also named a single Trustee, a gentleman acquainted with art, who should look after the artistic condition of the pictures. Of course, that is a kind of Trustee that is extremely valuable, and you could not dispense with that. If you ask me whether I see any advantage at all in official Trustees (I think there are 15 at the British Museum), I see nothing but disadvantage. Those gentlemen, the Archbishop of Canterbury, for instance, are all thoroughly engaged in other matters.

9101. That, of course, would be an objection to the constitution of the Board, but not to the existence of the Board?—I think to answer that question we must try and clear up what we mean by the board. I can conceive, as I have said, in answer to a question of Professor Huxley's, that if there were a set of Scientific Trustees to be called together as the Lord President thought fit, and to advise upon any vexed questions upon the management of the natural history at the British Museum, the Lord President would get advantage out of it, instead of having a wrangle before Parliament it would be a wrangle before them, and common sense would come out of it; to that extent I think that Trustees might be made useful. Then, of course, the property trustees must remain; but the weight of all my conviction is that I would not put public money at the disposal of a number of irresponsible Trustees.

9102. But you would not object to their having the power of recommending the expenditure of public money?—I think you would perhaps create a friction between them and the parliamentary responsible officer. I think, if the chief parliamentary responsibility thinks fit to ask their opinion, he should be free to do it, but I think they should not dictate to him what he should spend upon this part and what upon another.

9103. Is it not conceivable that there should be a Head of the Department fully qualified to authorise expenditure in certain departments of science and art, but at the same time not so qualified in the case



of the other branches, and that it might be necessary that he should have, besides his mere subordinate advisers, some authority whom it should be competent for him to consult when he thought fit, and whose advice might be appealed to in order to justify the expenditure of public money?—I think that some kind of consultative body would be useful, but I think it ought not to impair the authority of the Head. It should rest absolutely with the Head whether he takes their advice or not, and he should justify his decision to Parliament or otherwise. He should be in a position to justify any rejection of advice that he receives, but I think that it would be wholesome for him to have advice if he wishes to have it.

9104. Take for instance the purchase of a picture, or of some object like that which was spoken of in the earlier part of your examination: if he were not competent to advise or dictate the terms of that purchase, would you make him ground his recommendation to Parliament upon the suggestion of a subordinate officer of the department to which that object might be offered?—I think the course that is followed at Kensington is the right course. An object of value is offered for purchase; if it be one kind of object it goes to a man of professional eminence, who gets a fee varying from five to two guineas for his written opinion; if it be another kind of object, it goes to another kind of man, and if there be any doubt upon the subject, after obtaining the opinions, then it is referred to a second, and upon the decision, say of two, very rarely three, but generally one, upon the professional opinion of one, two, or three, as the case may be, the Lord President decides.

9105. Would those be extra official advisers?—Yes. I do not call them Trustees in the usual sense of Trustees. I am sorry, perhaps, to express an opinion that may seem a strong one, but I do not think that the public service is worth much unless it is paid for, and I do not think persons are to be found very strong as men of business for consecutive action, unless they are paid for their duties. There are cases, no doubt, in which we ask an opinion and are guided by it, but if you are to have the right of calling for the judgment of the most eminent men upon the subject, I think he ought to be treated like a physician or a lawyer. You must pay his fee.

9106. You spoke of the comparative cost per visitor of South Kensington, the British Museum, and the Crystal Palace: what inference do you draw from that comparison?—The inference that I draw is, that the British Museum costs three times as much as it ought to, which I attribute wholly to the system of Trustees, and three times as much as it would do, if, in two years, it were put under the Lord President. It is a matter of faith with me.

9107. That may be so, but is the inference a fair one merely from those figures; would it not seem that the cost per visitor is a test of the attractiveness of the institution which he visits, and not necessarily of the management?—I think that the attractiveness of an institution really depends altogether upon the management, and I will give you a recent instance. Some three or four years ago, after due deliberation, it was resolved to open the Geological Museum in Jermyn Street in the evening. It has been opened, and the result is, that the number of visitors are, I think, threefold, or, at all events, double what there were before. That is a question of management altogether. Whether few people or many go to the British Museum, in my opinion, depends altogether upon the management of the British Museum, assuming that the objects are not very recondite or unintelligible. In the case of natural history, I think it is the most popular thing that you can show people; but if your collections are crowded together, if they are imperfectly labelled, or labelled in unknown tongues, if they are dusty, and if they are dirty, and if the place is fusty, if it is not ventilated, and all kinds of other things that one might enumerate, all of which are remediable by management, I think you would say that the paucity of numbers is due to the management.

9108. Might you not have a very excellent collection very well managed, and yet make the expense of management so costly that each visitor, if that test were adopted, would have to pay uncommonly dear for his admission, and would it not rather depend upon the bad taste of the public and not upon the injudicious management of the institution?—I cannot fully assent to that proposition; I should like to give you another case. The Royal Irish Academy has a collection of gold work which is nearly as fine as the gold work of the Italians, which is in the Naples Museum. The last time I was in Ireland, by a sort of caprice, this gold work, as well as some beautiful metal work, was lying about wholly neglected, and covered with dirt and filth, and the public had great difficulty in going there. I should not be surprised if the visitors there cost 5s. a head for seeing the collection. You could get in, and you saw it under great disadvantages. It would not be fair to say that the expense is great because the collection is of a very valuable and recondite kind, and few people go. You do not encourage people to go, and you put difficulties in their way. Very much of that idea prevails at the British Museum. A friend of mine said to me this morning, If I want to go and see a medal at the British Museum, I can only see it by taxing the time of a public officer, who is paid 400*l.* a year. Of course nobody goes and taxes his time, or at least very few people are able to go through the operation of fishing him up, and finding him out in the room, and then he is bored, and you are impatient all the time, and you go as little as possible. If those things were displayed, as they might be, certainly a hundred times the number of people would go to see them.

9109. (*Chairman.*) Is there a large proportion of the expenditure of the British Museum caused by the collection of books?—The estimates presented to Parliament give a full account of the details, which may be analysed so as to show almost the cost of each separate department. The cost of attendants and assistants is divided, but is heavy; and I think that the system of appointment at the British Museum leads to an undue cost which might, with great advantage, both to the place as well as to the public taxation, be improved. I have heard it said that the British Museum is the refuge for all the invaluable butlers that gentlemen are grieved to part with, and, in my opinion, according to the way of looking after the public and keeping the place clean, the system at the British Museum leads to unnecessary cost, and is very dear. I think the figures that I have worked out show that. I think there is not sufficient classification of the kinds of services. A great part of the service of an attendant is that simply of a policeman, and there is great advantage in employing policemen rather than superannuated butlers, because, if you do not like B. 27, you can get B. 28, and you can pick the men and get the best men out of the force always, whereas, when you are fixed with 60 first-class attendants, and 70 second-class attendants, gentlemen entitled to superannuation, you do not get any prompt or good administration out of the system, and you virtually cannot get rid of them if you wish to do so.

9110. (*Mr. Samuelson.*) It does occasionally happen, does it not, that first-class butlers find their way into Government establishments conducted by paid officials?—They do find their way, but I am happy to say the rules at Kensington keep them at the minimum.

9111. Therefore, it would not do to throw the burthen of that entirely upon the fact of the Trustees being unpaid?—I think that if the management of the museum were more responsible, they would have less first-class butlers.

9112. I suppose you would look both to a saving in the cost of superintendence, and an increase in the number of visitors, in order to reduce the charge per head?—I think that you might have the British Museum better administered at a cheaper cost, and more done to encourage visitors. The facts, as now appearing, are, that every year the numbers decline. To say all this is very invidious, and I have

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C.B.

23 June 1871.



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great respect for the officers of the British Museum, but the facts are facts which apply only to the system. In 1870 the total numbers of visitors at the British Museum were 543,791, in the previous year they were 584,000. The year before they were 575,000, and so it goes on. The appreciation by the public of the British Museum seems nearly to have reached its climax, and something, in my opinion, ought to be done to make them take more interest in it.

9113. That may be owing, in some measure, may it not, to the counter attraction of South Kensington?—No, not at all. My faith is, that the more you have of such places the more they create a public to appreciate them. To give you a case in point, which has just occurred: the directors of the Crystal Palace were in much apprehension that their Handel Festival this year would not succeed, because the Exhibition was going on, and because there was an Albert Hall; but the result is, that their numbers are larger than they have ever been; and my experience is that things grow rather than decline. My belief is, that the attraction of Kensington has nothing to do with the decline of the British Museum.

9114. Setting aside the pictures, can you give, approximately, the value of the circulating collections of South Kensington, as compared with the stationary collection?—I could not do that, because we consider that anything whatever that can be moved, not a pulpit, not something that is obviously too large, and not portable, but anything that is portable, under the regulations, may be circulated. We have sent objects into the country which have cost us 2,000*l.* apiece, and we do not hesitate to do that if the reason be a sufficient one. The Queen, herself, has lent us porcelain and old Sèvres to the value of 15,000*l.*, which we have sent round the country; so that, in fact, with the exception of things not portable, you may say that the whole collection at Kensington is circulated.

9115. Do you find that the demand for your circulating collections is on the increase, or otherwise?—Much on the increase, particularly in that direction in which we are worst off, namely pictures, and there is a new kind of demand which is growing, and that is for scientific collections, which I foresee will increase very largely. I have no doubt whatever that, for little typical collections of natural history and matters relating to other subjects, food especially, the demand will very soon become large, and it is gratifying that it is so.

9116. If I rightly understood you, you spoke of having taken steps to stimulate the desire for the exhibition of those circulating collections?—We respond, as best we can, to the demands made. I do not know that we do anything more than that.

9117. But you do not send out any missionaries?—No, not specially.

9118. You also spoke of a Minister responsible to Parliament, do you mean one minister?—Yes, one minister.

9119. Do you mean a Minister who should simply be an administrator of museums?—No, I think that museums ought to be all under the Minister for Education. I think museums are one great instrument of education, and if they are not instruments of education, but merely looked upon as curiosity shops, they are not managed properly.

9120. Will you explain yourself a little further?—I think that the only kind of education that you can give grown up people, without seeming to be impertinent, is showing them things. Multitudes will come and get what good they can, and what knowledge they can, and what pleasure they can out of Kew Gardens, and Hampton Court, and the Kensington Museum, and the British Museum, and those grown up persons you can hardly approach by any other process. At Kensington our labelling is as complete and full as possible, so that visitors able to read can derive as much benefit as possible from seeing the objects and learning what they are.

9121. Is there any country in the world in which the national collections of pictures and sculptures are

under the Minister of Education?—I am not sufficiently acquainted with the administration of foreign countries to answer that question precisely. In Paris, although they have no Trustees, the different collections, are under many authorities. The Master of the Household, I think, has supreme power over the *Louvre*, and there is a good deal of friction between the *Louvre* and the *Bibliothèque Impériale*, which has many kinds of objects the same as the *Louvre*. I think there is rather a want of concentration there. With respect to other countries, the collections to which the public are admitted for the most part belong to the Crown. I am not able to say whether the Minister of Education in other countries has much to do with the subject. I have an impression that the administration is mixed up with the Ministries of Education.

9122. In France I believe there was a Ministry of Fine Arts under the Empire?—Yes.

9123. And that was looked upon as one in which the worst jobs were perpetrated?—I suppose it was likely enough, but I do not know.

9124. Do you think that if the Minister of Education really took charge of the education of the country, as its head, he would have time left to consider museums, and more especially museums of fine arts?—Yes, plenty; it is only a question of organisation.

9125. You do not think that there is any danger of his merely becoming the mouthpiece of others?—I think it is his own fault if he does. The same thing might be said of the Foreign Office, the Home Office, the Board of Trade, &c.

9126. Even if he knew nothing of the fine arts, though he might be an excellent Minister of Education?—It is not his business to know anything of the fine arts. A political minister is not chosen in our country for any special knowledge of his particular department; he is chosen for many other considerations; and, likewise, he can always get the best professional advice that he wants. I think special ministers are usually very imperfect instruments, they affect to know things, and sometimes they make great mistakes. If they go against the advice of their professional advisers, who are paid to advise them, I think they usually make mistakes.

9127. Do you think it desirable that the Minister should know nothing practically of his department?—He ought to know everything, as far as human nature will permit him. But a Parliamentary Minister is a totally different instrument from a professional adviser, and if you attempt to mix them, you will be sure to get wrong.

9128. Even in cases which are not very technical, would that hold good?—That is another point. A Political Minister is supposed, amongst other things, to have, and usually has, strong instinctive common sense. He knows what the feeling of the public is; he knows what Parliament thinks about things, and if he is not a man of common sense, then, of course, whoever makes him a minister is answerable. But, if he be a man of common sense, and he can get the best advice, and the Treasury allows him to pay for it, then his common sense guides him to a right decision, which he can justify to Parliament. If the theory that seems to have been pointed at be correct, the best Chancellor of the Exchequer would be a great financial administrator; but I do not know that you select Chancellors of the Exchequer for having shown that they are very successful in finance, or political economy, or banking, or commerce, or anything of that sort.

9129. Who do you say should represent the Department of Museums in Parliament?—The Minister of Education, or his deputy.

9130. You would have all the museums under one minister, and that minister should be the Minister of Education?—I would certainly.

9131. On the ground that museums are an instrument of education?—Yes, distinctly on that ground, and that they are of very little use if they are not so treated.

9132. When you spoke of the Patent Museum, did I correctly understand you to give that as an instance of



defective administration by an unpaid Commission?—Yes; by a Commission of Members who have other work to attend to, and not specially paid for administering it.

9133. But they are men of common sense, are they not, having officers under them, as the Minister would have?—That may be so, but I do not think that lawyers, who are busily engaged, are the people to direct and manage a museum.

9134. What are the defects to which you would point in the Patent Museum?—It seems to me almost asleep.

9135. Are you prepared to say what ought to be done, and how it could be made useful?—If so be that Parliament thinks fit to unite together all the various objects which may be considered to come under the class of mechanical and scientific, then I think it would be made a museum like the *Conservatoire des Arts et Métiers*, which ought to be under a Minister with proper responsible Directors.

9136. Do you mean a museum of industry, or merely a repository of patented inventions?—I point particularly to the mechanical. Perhaps you may include some others; but the Patent Museum professes to have the models of patents, which are usually very imperfect things, and very different, probably, from what the ultimate result of the patent shows, together with types of ancient inventions and samples of mechanism, which are specimens rather of history than of anything else. You have somewhat the same kind of thing going on in other institutions, and I think it is a pity that they should not be all together. I do not see why you should have the pattern of a screw in the Patent Museum because it is originated by a patent, and a number of patterns of other screws exhibited by the Lords of the Admiralty because they are connected with ships. I do not know why the public should have screws in two places.

9137. Are the two museums visited by the same class of people?—I should think that the men who went to look at the screw of a steamer were the same class in both places.

9138. Are the people who generally come to the Patent Museum the same people who would go to the Admiralty?—Certainly, if they are interested in the naval part of the business. You have models of boats and models of steamers, of anchors, and all kinds of things connected with the marine, which may or may not have been patented, but which somehow or other have got into the Patent Museum, and you have precisely the same kind of things, within 700 feet, belonging to the Admiralty, in the Museum of Naval Architecture.

9139. Substantially, you may say that they are almost under one roof?—No, I cannot say that; they are under different roofs, and under different management; and they are 700 feet apart.

9140. Still, there would be no inconvenience in a visitor passing from one to the other?—He would get wet if it were a wet day, and probably would not go. The public space is occupied in both places, the public money is paid for administration in both places, and I have not any doubt at all that both space and money would be economised by putting like things with like things, and the public would not have to pass from one place to the other, and perhaps not see the things after all.

9141. Would you put the collection of Naval Architecture under the Minister of Education?—Yes, without a doubt. It is the case now with great advantage. When it was under the Board of Admiralty it was not to its advantage, it was perpetually shifted about, sometimes in a garret, and sometimes in a cellar, and the public could not get at it. Where one person saw it 10 years or 15 years ago, I should say a thousand see it now. It was not labelled, it was not catalogued; till it got into the charge of the Lord President, there was no such thing as a catalogue, there was not a list, and whatever state it is in now is owing to its being under a Minister of the Crown

without impediment. Some old Admirals used to think that the Navy would go to the bad, if the public were allowed to look at the models of ships; that was the kind of tradition which existed when Kensington first took charge of them, and they only came over into the charge of the Lord President because Lord Granville made it a condition that if the Department were to be responsible for the School of Naval Architecture, the models should be free to the students to inspect and use, and that the public should get what good they could out of them: after the usual kind of fight that takes place between two Departments, Lord Granville was peremptory, and the things came to Kensington. They are now seen and enjoyed by thousands, whereas, formerly, units hardly saw them. Added to which, when those models were in the cellars at Somerset House, there was no useful connection between the private ship building trade and the Admiralty. Now, we have no difficulty at all in getting presents and loans of the finest models from the private shipbuilding firms of the country, and we exhibit them readily, with great advantage to all parties.

9142. Would you put mining models under the same roof, if you had an opportunity of doing so, and under the same control?—As long as you have a mining school and a mining library, and specimens of the mining trade, that is a distinct speciality, and I should leave these objects where they are. Whether it might, or might not, at any time, be expedient to have the mining school and its objects part of a larger scientific institution is another question. If so be that the mining school were part of a great scientific school, then I think that the mining models might form part of a *Conservatoire des Arts et Métiers*.

9143. You would consider it no serious objection that the school should be on one side of the road and the models on the other?—I should consider that there was no serious objection if there were easy and covered communication.

9144. When you extended the functions of the Minister of Education, by giving him charge of all the museums, would you think it proper to relieve him of cattle plague, and quarantine, and other matters of that sort?—Certainly, I should do that without reference to the museums.

9145. (*Professor Huxley*.) Is the National Portrait Gallery under the Lord President?—No, not under the Lord President; we are merely watchmen; we merely provide the watching and the police, and a certain part of the cleaning. But there is a somewhat curious fact connected with the National Portrait Gallery, and that is the great increase of numbers (and that bears upon this administration question) that has taken place by removing it from, what is supposed to be, a central situation, to an inconvenient situation. In the year 1870, the National Portrait Gallery at Kensington was visited by 58,900 people; it was only opened nine months in the year, from April; whereas, in the preceding year, when it was in Great George Street, and when it was open all the year round, excepting at Christmas, the numbers were only 24,416, so that, in nine months, the numbers have been more than doubled by moving it to Kensington, with altered rules of admission. If you ask me what are the reasons of that, I say because the things are much better exhibited, because the public get at them much easier, and because they are known to the public to be there; in point of fact, it is owing to better administration.

9146. How has that happened?—It has happened by the Treasury insisting that the National Portraits should come down to Kensington, in some rooms which could be applied for the purpose there. Great apprehension was expressed at their being moved from Great George Street, but the Treasury was peremptory, and insisted upon their coming, and such has been the result, that double the number of the public have visited the place, although in a distant situation, because the administration is improved, than did so when they were at Westminster.

H. Cole, Esq.  
C.B.

23 June 1871.



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C.B.  
23 June 1871.

9147. In Great George Street the collection was in a private house, and they had to go and knock at the door?—Yes; it was open upon three days in the week, but nobody ever went there that did not find that he came on the wrong day. I never saw the collection in Great George Street, though I made one or two attempts.

9148. (*Chairman.*) Would you think it desirable that any public money should be spent upon provincial collections?—I think that it is most desirable. I think the subject wants careful consideration, but it would be desirable to give a small grant in aid of the buildings of museums in localities; it need not be very large, enough to stimulate the localities doing the greater part of the work. And I think that it would be certainly advantageous to extend generally the principle

of circulation. I would also give them increased aid in the purchase of things. When Mr. Henley was President of the Board of Trade, he passed a Minute which enabled any museum, or rather any school of art, in the country to have superfluities out of the Science and Art collections at half the original cost. If we put aside anything that we do not want, then upon the locality paying half what it had originally cost, it might obtain it. But this assistance has hardly been taken advantage of. The idea is beginning now to simmer a little. Birmingham is starting a museum of manufactures, illustrative of the trades of the district, and Birmingham desires to take advantage of that Minute; excepting that case, there have been very few places indeed, that have cared to take advantage of it and pay for it.

The witness withdrew.

Adjourned.

6, Old Palace Yard, Westminster, Tuesday, 11th July 1871.

PRESENT :

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., IN THE CHAIR.

Sir JAMES PHILLIPS KAY-SHUTTLEWORTH, Bart.  
WILLIAM SHARPEY, Esq., M.D., Sec. R.S.

THOMAS HENRY HUXLEY, Esq., LL.D., F.R.S.  
HENRY JOHN STEPHEN SMITH, Esq., M.A., F.R.S.

L. Bell, Esq.

11 July 1871.

ISAAC LOWTHIAN BELL, Esq., examined.

9149. (*Chairman.*) You have been for many years extensively engaged, have you not, in some of the principal industries of the North of England?—Yes, I have been engaged in the manufacture of iron and chemicals—to a certain extent in the manufacture of lead, and at present somewhat extensively in the mines of ironstone and coal in the North of England.

9150. Have you taken an active part in promoting the establishment of the College of Physical Science, which I believe at the present moment may be said to be actually formed at Newcastle?—Yes, I took a part in it some years ago, but at that time, from some circumstance or another, it failed. I suppose the necessity of such an institution was not felt so generally as it is at present; for although we had a very handsome offer from the Duke of Northumberland of that day to assist us in its establishment, the public did not regard favourably those endeavours at that time, and in consequence the scheme fell through. There was a variety of circumstances given as the cause of the failure, but suffice it to say that it was unsuccessful. It has been taken up more recently, in fact I may say within the last two years, and the negotiations were so far advanced that we were enabled, about three or four months ago, to bring the matter before the public, and it has been very warmly received and cordially responded to; so much so, that the money that we calculated upon requiring, which was 30,000*l.*, has in a great measure been raised. I think, at the present time, we have got somewhere about 26,000*l.* out of the 30,000*l.* I say 26,000*l.*, because that includes a promise of 300*l.* a year from different sources, and we have capitalised it, and that brings the sum up to somewhere about 26,000*l.* In fact, we have no apprehension whatever of not being able to raise the remainder.

9151. You have 1,000*l.* a year promised, also, have you not, from the University of Durham?—Yes; in fact that really was, I may say, the commencement of the present movement, for the proof the University of Durham afforded to the manufacturers in the North of England of the earnestness with which they regarded the establishment of a College of Physical Science really was, as it were, the germ of the attempt we are now making.

9152. Has your knowledge of the state of scientific instruction among those engaged in the industry of

the district led you to form a decided opinion that an institution of the kind is needed?—Yes, I entertain a very strong opinion upon that point. I think it is essential for the progress of the industry of this country, looking at the footing upon which it is placed now, that those to whom is entrusted the management of large concerns should have generally a higher class of education than that which they possess at the present time. At the same time, I am bound to say that very great progress has been made by many in spite of their want of instruction upon those questions which, in my opinion, are of vital importance.

9153. Have you, and those with whom you have acted, agreed very generally as to the character of the College which you desire to see established; that is to say, as to the branches of science which you wish to see principally attended to?—We are quite unanimous upon the branches of knowledge which we ought, in the first instance, to undertake, which are, abstract science, namely, pure and applied mathematics, chemistry, geology, mineralogy, and physics. We are quite unanimous upon these as a commencement, and we are also unanimous, I think, that, as soon as the College has the means, we should have other chairs; for example, a chair of biology, and a chair of mining, and civil engineering. I have no doubt that those will follow, but, in the first instance, it is absolutely indispensable that you should have the pupils trained and instructed in the abstract laws of which, of course, those other chairs are mere applications.

9154. Then it is intended that, at the outset, the instruction should be of a purely scientific character?—Yes, of a purely scientific character; and, as I said before, I hope to see the time when we shall have a chair of civil and mechanical engineering, of course including mining; and I would suggest, possibly, a chair for the teaching of navigation as well, which is a very important matter, looking at the entire change which has come over the nature of the carrying trade of this country. Formerly, almost all our transport by sea was carried on in small vessels of insignificant value, and generally commanded by men of little, in fact, I may say, of no scientific knowledge whatever. Now, on the contrary, the vessels are of a very large character, very costly in their construction, and almost uniformly propelled by steam. So that I cannot doubt that if a person commanding



such a vessel, in addition to the ordinary knowledge of matters on pure navigation, also, could be made to combine those of a mechanical engineering character, it would be to the advantage of the carrying trade of the country.

9155. Do I understand you to say that the character of the teaching is not intended to have reference to the application of the sciences to practical purposes?—I would scarcely go as far as that, because, speaking from my own experience as a student many years ago, almost the whole range of chemical science, and other sciences, too, at that time even, was always illustrated by their direct application to the Arts. For example, I never remember any lecture upon heat in which its application to the steam-engine was not dwelt upon, and in the same way, in treating of the chemical properties of iron, I never remember hearing a lecture given upon this metal in which the mode of its manufacture was not described; but still, in a course of lectures of a general character, those matters are necessarily treated in a limited manner. A chemical professor, for example, does not, and in fact could not be expected to go so thoroughly into the reduction of iron ore as a professor, we will say, at Leoben or Liège, or any other place with distinctly endowed chairs, for the purpose of teaching metallurgical science. This is a class of instruction which I consider is much wanted in this country.

9156. Has the question of applying to the Government for assistance been considered by those who have been engaged in founding the College at Newcastle?—Yes, it has. Of course, we are very anxious to get money from whatever quarter we can.

9157. What is the opinion generally entertained upon that point?—I think my colleagues generally are greatly in favour of receiving aid from the Government. Personally, I entertain a very strong opinion upon that point. I cannot help feeling, when I come to London, and I go to Jernyn Street, to Kensington, or elsewhere, and I find Government money applied, I do not say otherwise than very properly applied, for the purposes of instruction, that London is not the best place for teaching many of those sciences. You have no means of seeing their application, and, in consequence, of concentrating, I may say, your scientific men in London and other seats of learning, there is a class of men I find on the continent almost entirely wanting in England, namely, men of science who have devoted a great portion of their time to questions of applied science. If an English ironsmelter wishes to inform himself at all upon the theory of ironsmelting, or any other matter connected with metallurgy, he is obliged for original research to go abroad. He must either be able to read German or French, or both, or he must be content with some translations which have made their appearance in this country. I do not mean to say that there are not a number of gentlemen in Great Britain who have not given great attention to these questions, and who have industriously recorded a great deal of everything which has been done, in this country and elsewhere, and in so doing have materially promoted the science of metallurgy; but there are scientific men abroad—for example, Karsten, who wrote several volumes upon the manufacture of iron, Grüner, Krans, Ebelmen, Tunner, Lan, and a great many others, who not only possess great scientific acquirements, but they devote their scientific knowledge to the careful observation of the operation of the blast furnace, of the manufacture of steel, or of the rolling mill, or puddling.

9158. (*Sir J. P. Kay-Shuttleworth.*) Your desire would be that there should be, in the great centres of industry, scientific men who should be giving their attention to the scientific explanation of the phenomena of industry by which they are surrounded?—Exactly. I might take another case, and it happens to be a still older one. In the French war, at the close of the last century, our neighbours were unable to obtain American potashes, when all vessels carrying English produce, or, in fact, produce of any kind, were stopped by our vessels of war, there was a grave question arose

in France, viz., obtaining a substitute for potashes which they could no longer get from America. The alkali, soda, was perfectly well known, but the means of producing what you may call the artificial alkali at that time was very imperfectly understood. The French Government offered a reward for any man who would discover the means of obtaining soda easily from common salt, which, as was well known, contains this alkaline base. The result of that application to men of science in France was the discovery of Leblanc's method of getting soda. That, I suppose, would be somewhere about the year 1792, and that has continued to be the process of making soda in France and in this country from that time down to this. I do not say that we have not slightly modified it; we have certainly economised it, as you may judge from the fact that, at that time, soda was selling by my predecessors in the North of England at 60*l.* a ton, that which last year was sold for 60*s.* I may mention that this School of Science in the North of England is gaining great favour, as may be evinced by the fact that the Corporation of Newcastle unanimously last year voted 100*l.* a year towards its maintenance, and as the Corporation of Newcastle represents, you may say, the generality of the ratepayers and men connected, not only with the manufactures, but also with other interests, you may judge from that that this body attaches great importance to it, and I may state generally that the necessity of scientific instruction is daily becoming more fully recognised. For example, there are established in Newcastle two or three professional chemists who are solely employed in making researches for manufacturers with regard to the value of the materials they are about to purchase, the generality of which are now bought upon what is really their commercial value. I remember quite well the time when purchases were made at prices based upon the usual character it had in the market; but now, if a manufacturer is going to buy, we will say, black oxide of manganese for the manufacture of chlorine, it is uniformly bought according to the quantity of pure oxide of manganese that it contains. Coke is now esteemed by the iron trade in Middlesborough according to its freedom from ash and sulphur, therefore, showing how the value of this article, which has become one of enormous consumption, is recognised by the quantity of pure carbon which it contains, and also its freedom from what we consider a deleterious substance, namely, sulphur. We may reasonably hope, by having men of pure science settled in manufacturing districts and brought in contact with those great industrial questions of the day, that they would be more likely to have their attention directed towards departments, metallurgical or mining, or any other applied science, than they could possibly have here in London, where they rarely have an opportunity of meeting either the one or the other. In Germany, in France and Belgium, in Sweden, and, in fact, wherever I have gone, you find men of great scientific acquirements whose attention has been directed, I will not say exclusively, but very greatly, to science applied to art, and you invariably find practical schools of science established where the practical science is itself required.

9159. (*Chairman.*) I do not understand that you would desire that such schools should be entirely supported by the Government?—No; I think that the best guarantee which a community like that of Newcastle can give to the central body, namely, the Government here, of the necessity of establishments of this kind, is, by doing something themselves, and asking the Government to assist to a certain extent.

9160. Have you any decided opinion as to the form in which Government assistance could best be rendered, supposing it were decided that such assistance should be given?—No, I cannot say that I have any decided opinion.

9161. Or with regard to any particular professorships?—I do not suppose that it would be very material in what shape the assistance came; if the Government choose to endow professorships, or make

*J. L. Bell, Esq.*  
11 July 1871.



*L. Bell, Esq.*  
11 July 1871.

pecuniary grants for the general purposes of the College, would be a matter of indifference.

9162. Are you able to state whether the Royal School of Mines in Jermyn Street has had any influence on the industry of the district with which you are connected?—I cannot say that I have been able to trace it, but it is, perhaps, that I am not acquainted with the particular institution at which every young man who was destined for either the mining or manufacturing profession was educated; at the same time, it must be perfectly understood that I do not offer any disparaging opinion with regard to the school. I have the pleasure of knowing some of the professors there, and I am quite certain that there are abundant means afforded in Jermyn Street of acquiring a perfectly sound scientific education; and if any student goes there and does not learn, it is not the fault of the teachers.

9163. Do you know any persons engaged in any of the works at Newcastle or the neighbourhood who have been educated at the College of Chemistry, which, as you are aware, may be considered as a portion of the School of Mines?—No. I know more who have been educated at King's College; it is quite possible, however, that there may be some in the North of England who have been educated in Jermyn Street.

9164. What class of persons do you anticipate will form the chief portion of the students at the College?—To be of the use that is expected from the College, I would hope that young men who seek to become managers of manufactories would be educated there. As I said before, our manufactories in great measure have been superintended by practical managers without any particular scientific acquirement, and the fact is, that we have only had a poor chance of retaining as foremen persons of education, because an education such as I consider essential is so rarely met with, that a young man who possesses any scientific knowledge very soon gets advanced beyond the position of a mere foreman. The market is not sufficiently well supplied. I have had experience myself of having self-taught men as chemists, who proved themselves very able men as managers, but they were very soon able to take their talents to a very much better market than I could afford.

9165. Where do they find a better market?—The better market was this, that they commenced business for themselves. There are always people to be found with capital, but without special knowledge, who are very glad to find a person of sufficient scientific acquirements, and sufficient ability and character to whom to offer a partnership.

9166. Do you think that the influence of the Foreign Schools of Mines has made itself visible in any improvements which have been introduced on the continent, which you do not see examples of in England?—I really cannot say but what we have held our own place wonderfully. There was an outcry made, I daresay you may remember, a short time ago upon the alleged decadence of the manufacture of iron in this country as compared to other nations, or, perhaps, I should put it more correctly that the manufacturers abroad were greatly outstripping us. I thought it necessary to defend my fellow-manufacturers, who I thought were unduly disparaged, by proving that in point of fact, really, almost all the great improvements in the manufacture of iron had emanated from this country.

9167. In spite of their want of science?—Yes, in spite of their want of science. We were the inventors of the blast furnace; of the hot blast; of puddling; of rolling; and of Bessemer steel. I should like any person who entertains a different opinion to mention any discovery of a more important nature than these; but I think, notwithstanding, we may very often be misled from want of sufficient scientific knowledge. I will state a case which is attracting a certain amount of attention at the present time, namely, the quantity of fuel required in the smelting of iron. To any one who has paid any attention to this question, it is a perfectly well-known fact that the absolute quantity of heat evolved by the combustion of coal, as it is burnt

in the blast furnace and utilized, is only to the extent of 50 per cent. of its full power. The question waiting solution is, whether the nature of the process admits of further improvement, and, if so, its extent, and we might be, in the absence of scientific inquiry, led into a very expensive search after this 50 per cent. which we are losing now.

9168. (*Sir J. P. Kay-Shuttleworth.*) Considerable advance has been made in the economy of heat in the process of smelting, has there not?—Yes, very great, indeed. When we first commenced blast furnaces at Middlesbro', we thought that we were skilful smelters if we could make a ton of iron with 35 cwt., whereas it is now reduced to 22 or 23 cwt. Of course, there is always one question of a non-scientific character of which we cannot lose sight. We may be carrying on an operation in an imperfect way, but we cannot afford to ignore the question of what we are going to gain by any economy introduced in the manufacture. That we must keep before us, and if the cost of the means of saving the coke that I have just spoken of exceeded the value of the coke, of course we turn a deaf ear to the science, and we go on in our old way; but, at the time that I spoke of, the value of coke in the North of England was 6s. a ton, whereas it is now 12s., and we can afford now to do, and in fact are compelled now to do, that which we could not do before.

9169. Probably it is in consequence of the great part which the economical question plays in all those improvements in manufacturing processes, that a very great proportion of the suggestions tending to invention have proceeded from working men, and very often from men without anything beyond a practical knowledge?—I do not quite understand whether the honorable baronet is speaking generally.

9170. That is almost universally the case, for example, in the textile manufacture, is it not?—With that I have little acquaintance, and, therefore, cannot say, but certainly in those operations which are more or less of a chemical nature it is not so. I can quite understand that a man daily watching the action of a shuttle may raise himself to the position of an inventor; but if an improvement is to be suggested by a distinct knowledge of the chemical properties of a body, which properties you cannot see, and which you cannot trace, then I think probably you will find that very few improvements indeed have emanated from uneducated men in recent times. About the year 1840 or 1839 it struck the King of Naples that it would be a very wise thing to lay a heavy duty on sulphur, because he knew quite well that at that time he had the monopoly of all the sulphur in the world, practically speaking, and accordingly he sold this monopoly to a French company, who raised the price of sulphur in one twelvemonth from about 5*l.* a ton to 13*l.* No working man could have devised a substitute for sulphur, but a chemist, who knew perfectly well that bisulphide of iron, or ordinary iron pyrites, might, by suitable treatment, furnish our chemical works with sulphur. That of course required knowledge which no purely practical man could by any possibility possess.

9171. The tendency of my question was by no means to disparage the value of scientific knowledge, but what I wanted to bring out rather was the exceeding economical value of practical knowledge in combination with scientific knowledge for the development of new processes?—Undoubtedly; and that, really, to a great extent, is the drift of my argument. I am simply putting the matter rather in a different way to that in which you have put it; that is to say, that the manufacturers themselves must have a certain amount of scientific knowledge in order to make the improvements which we are speaking of.

9172. Did not the conviction of the exceeding value of practical knowledge tend in former times to some rather exaggerated ideas as to the mode of training young men, for example, in mining and engineering, without any previous or accompanying scientific instruction?—I have no doubt of it; in fact, I am quite old enough to remember the time when you could not



say a more disparaging thing of a manufacturer than to say that he was a man of theory—a mere man of theory being a man who was really educated in the principles of science. You cannot get the manager of works, a man of no education at all, to take proper interest in an improvement in the absence of all kinds of information on the matter. If you take any operation, say chemistry, you often fail at first, and fail because the men to whom you have to entrust its elaboration, of course, are new to it. An ordinary manager of works, having no skill in a new operation, and being guided by no hope from having a knowledge of that which possibly may be accomplished, loses heart, and I have no doubt that many failures have really resulted from this want of knowledge.

9173. I gather that you are hopeful that the exaggerated reliance which has, in times past, been placed upon mere practical knowledge is being, in the north, superseded by a just appreciation of the value of scientific knowledge combined with practical?—Yes, that is my very decided opinion.

9174. And you think that it would be a great advantage to manufacturers in the north, if men of the highest scientific qualifications were induced, by being appointed professors, or by other motives, to settle in the great centres of those manufactures, and if their knowledge were available both as a source of instruction and likewise as a means of improving the processes after scientific observation?—Yes, such is my belief. I am far from supposing, however, that anyone possessing scientific information ought necessarily to be expected to propound and carry into practice discoveries of great industrial importance, for these require constant study and close attention. As an instance, I might give the Pattinson process of desilverizing lead, a very simple operation, but one which I know personally required both time and considerable scientific knowledge for its elaboration.

9175. When some considerable discovery, like Faraday's benzene, or Scheele's discovery of the influences of chlorine, comes into the hands of men of partial scientific knowledge and of constant habits of observation, they apply this knowledge to manufacture?—I forget about benzene, but Scheele's discovery of chlorine came into the hands of Charles Tennant, of Glasgow, the manufacturing chemist of that day, and he applied it to the purposes, as we all know now, of bleaching. In fact I do not know where we should be if we had not chlorine now; for it would be impossible to carry on the manufacture of paper in this country without chlorine, or some substance of an analogous character, because esparto grass, which has supplanted in a great measure the use of rags, would be useless without bleaching powder and cheap alkali.

9176. In the same way, with regard to aniline, and the colours which have been consequent discoveries, these have been developed by many persons, some of them of considerable scientific knowledge, but generally in connexion with manufacture?—I take it that that will always be the history of these things. First of all, there is a man who elaborates scientific truth: I may take the case of Oersted's discovery of the deflection of the magnetic needle by electricity, subsequently applied to the electric telegraph.

9177. You would have both men of a high scientific class devoted to research, and men of similar capacity devoted to instruction, and you would have them placed in the centres of manufacture in order that their influence might in various ways be felt in the development of manufacturing prosperity?—Yes, I would. Of course, I must not be understood as pretending that men of pure scientific attainments never make brilliant discoveries in matters of practical application. The contrary is proved by Sir Humphry Davy's invention of the safety lamp, and by many other cases.

9178. (*Dr. Sharpey.*) Would you kindly mention what is the usual course of a young man who wishes to become an engineer, or a manufacturing chemist, or a metallurgist?—If you will take a mining engineer,

the usual way almost without exception, I think, is, for young men to become apprentices to mining engineers; and so with chemical manufacturers; but, as a rule, previous cultivation of science, in my opinion, has very often been too little attended to.

9179. Would you understand that those young men would go through the purely scientific branches of preparatory study before they entered upon their pupilage with the engineer or the manufacturer?—That would be a difficult question to answer, and I have no doubt it would vary a good deal with the individual. For example, with some persons, possibly, having once thrown off what they might consider their schoolboy days, they might not like to resume them; but there are other young men who, perhaps, having been at school and then sent into a workshop, and finding how valuable a certain amount of scientific knowledge would be, might apply themselves with greater energy to scientific study.

9180. With respect to the courses of applied science, such as engineering or manufacturing chemistry, or metallurgy, would you recommend that the pupils should first of all learn something of practical work in an engineer's office, or in a workshop, before they go to those practical classes, or might they be simultaneous?—Certainly not simultaneous. If he were engaged in a workshop, I am quite certain that the physical fatigue which he would have to undergo would render him utterly unfit for attending properly to his duties as a student. Besides this, there would be divided attention, which, in my opinion, is unfavourable for mental labour.

9181. Would you have him go through those courses of applied science in a science school before he enters on his apprenticeship or pupilage?—On the whole, I think this would be the best mode of procedure.

9182. I was thinking of any curriculum which might be proposed for the students in the School at Newcastle?—In some cases, I do not think it would be a bad plan for a young man to go into a workshop for two or three years, and there learn how much he was required to know, to act as an incentive to him in endeavouring to acquire the necessary knowledge.

9183. (*Professor Huxley.*) Are you acquainted with the system of the Whitworth scholarships?—No, except just reading about them in the newspapers.

9184. Do you know the general arrangements and plan of the scholarships?—Merely from reading of them at the time.

9185. Young men obtain them by examination in the first place, and then pass into the workshop?—There you see the workshop follows an amount of study.

9186. There is also a practical examination in the use of tools as part of the examination?—Yes. There has been a good deal said in this country about the necessity of having practical workshops, where the young men can learn their business. I think the proper way is to be thoroughly grounded in abstract science in the first instance. Whether it may not be advisable to take a young man into the workshop at a time of life, perhaps, when he accommodates himself more easily to a state of things entirely different from that to which he has been accustomed, I am not prepared to say. I think possibly it might be. But I am certain of this, that when a young man is beginning really to learn the science which is to assist him in after life, the proper thing is to throw all practical questions aside, and devote himself to pure science exclusively.

9187. (*Dr. Sharpey.*) I asked you the question with reference especially to engineering, because some eminent persons have pointed out that there was a difficulty in instructing students in science applied to engineering when they were unacquainted with many of the objects to which they would have to refer; for example, although the professor might speak of connecting rods and various things of that kind, they had no notion of them, and it was thought that, before entering upon the courses of science applied to engineering, it might be useful to get some practical acquaintance with the objects; but that does not apply

*I. L. Bell, Esq.*

11 July 1871.



*J. L. Bell, Esq.*

11 July 1871.

so much to chemical works I presume?—No. I do not imagine that the absence of that knowledge would be a very great bar to a young man to learning those branches of science intended to be taught in such a school as we propose establishing at Newcastle.

9188. Would you advocate at all the establishment of workshops in connexion with the College?—No, I would not. I think it would be labour in vain. In the first place, it would be a never-ending source of expense. A planing machine of to-day is unlike a planing machine of 10 years ago, so that unless you were prepared to fit up such a workshop with improved tools, it would be of little service.

9189. You mean that the school workshop would be behindhand with the actual factory?—Undoubtedly it would.

9190. And the practical manufacturer would be in advance of the professor?—Yes. It would be, of course, an advantage if we had such a school as I am advocating established at Newcastle, and then enlarged so as to embrace civil and mechanical engineering. Nothing would be easier than for the professor to have a field-day on which manufacturing and similar establishments could be inspected. I do not say that you cannot see any of them in the neighbourhood of London, but you cannot see them as you see them with us, where they are so numerous.

9191. That would be a strong reason for establishing such a school on the site of manufacturing industry?—Yes, certainly.

9192. (*Professor Smith.*) How soon is it proposed that the classes of the Newcastle College of Science should commence?—I should answer that question by laying on the table the last decision which was come to on the 25th May, which is as follows:—

The NEWCASTLE-UPON-TYNE COLLEGE OF PHYSICAL SCIENCE, in connexion with the University of Durham, will open on Saturday, the 7th of October next.

THE course of study will extend over two years. There will be three terms in each year. The length of each term will be from 10 to 12 weeks.

Lectures will be given by professors on the following subjects: pure and applied mathematics, chemistry, experimental physics, geology, mineralogy, and biology. Special attention will be paid to the application of science to engineering, mining, manufactures, and agriculture.

The charge for each course of lectures will be five guineas a year; a separate charge will be made for the use of the laboratory; the fee for admission to the college will be one guinea.

Four exhibitions of 15*l.* a year each, and tenable for two years by persons pursuing their studies at the college, will be open to public competition in the week after the meeting of the college.

Two similar exhibitions will be awarded to the two candidates for the examination held on June 12th, 13th, and 14th, by the University of Durham, for persons not members of the University, who shall most distinguish themselves in subjects allied to physical science, supposing them to attain a sufficient standard of excellence.

Applicants for admission to the college are desired to communicate with Mr. Theo. Wood Bunning, College of Physical Science, Newcastle-upon-Tyne.

9193. You have got over the difficulty about buildings altogether, have you not?—We have got over the difficulty about buildings by an offer of accommodation of lecture rooms already in existence. These are very good, but the building or buildings in which they are placed are deficient in laboratory accommodation. At the same time, I should greatly prefer a building expressly erected for the purpose of the college.

9194. But you have at present sufficient accommodation for a chemical laboratory?—Yes, but the chemical laboratory is rather a weak point with us.

9195. (*Chairman.*) I believe you have four professors actually appointed?—Yes; but there is another professorship which we are very anxious indeed to see appointed, as forming a very important groundwork of the geological chair, I mean that of biology. We have not yet been able to see our way to appointing a professor to such a chair from want of funds, but we attach great importance to it.

9196. Do you think it would be difficult to form the College on the scale that you would like to see it without some assistance from Government?—Upon the scale I should hope to see such an educational institution established, I think there will be some difficulty in obtaining a continuance of that support which will be required for its maintenance. Besides, there is the moral status, I think, that a grant of that kind affords to an establishment like that of a College of Science. Recognition on the part of Government, of such an institution being necessary, would carry a certain amount of weight.

9197. Do you contemplate the College always retaining its scientific character, and not becoming a place of general education, like Owens College?—No, I will not say even that. If means were afforded to us, I do not say that I would not like to see its usefulness extended.

9198. (*Sir J. P. Kay-Shuttleworth.*) Have you formed any conception of the connexion which the College of Science in Newcastle might have with the Durham University, so as to enable the University to grant proper diplomas or certificates of scientific acquirements which might be useful as stimulants to students in the course of their study?—Yes, I think that that is a very great convenience, and is a ready mode of ascertaining at once whether a young man, either in mathematical or chemical knowledge, has acquired a certain position by his being the possessor either of a certificate of merit, or a distinct degree granted by the University; and as we have found the University already provided with all the means of granting such certificates, and willing to assist us, I think the affiliation of this new body with the University of Durham is a very admirable one.

9199. You would probably think that that affiliation and the recognition by the Government would form a part of the stimulus to public opinion in the North of England, and be the source of benefactions and bequests for the furtherance of the objects of this College of Science?—I entertain a very strong feeling in favour of that view.

9200. (*Chairman.*) Can you tell us what arrangements have been made with respect to the government of the new College of Science at Newcastle?—The University of Durham, by virtue of its gift of 1,000*l.* a year, at the present moment reserves to itself the election of two of the professors, but so far from wishing to introduce a greater amount of influence in the government than it might be supposed to be justly entitled to, under all the circumstances, reserves one third only of the representation upon the governing body.

9201. I believe that the endowment by the University of Durham was conditional, was it not, on a certain amount being raised by the public, which has been raised, and, on that being secured, they were willing to make the whole of the arrangements permanent with respect to money, and in other respects also?—The first idea was to make it an experiment for six years, that is to say, the University would endow the College with 1,000*l.* a year for six years, provided we did the same. The fact is we were rather apprehensive regarding the success of the scheme at first, seeing how little success had attended all our efforts before, and we thought we might only meet with a moderate amount of public support; but when we found we were able to raise 1,000*l.* a year in perpetuity, then, of course, we altered our plans, and instead of attempting to get, I think, some 15,000*l.*, we went in for 30,000*l.*, and, as I have told you, we have obtained promises for nearly 30,000*l.*, so that there is no question about the permanent means of being able to carry it on upon a limited scale; but, to place the intended College at Newcastle upon the footing upon which I should like to see it established, more means will be required, and I think we are, if Government extends assistance to any educational establishments, fully entitled to be similarly treated.

The witness withdrew.



SIR WILLIAM G. ARMSTRONG, C.B., D.C.L., F.R.S., examined.

Sir W. G.  
Armstrong.

11 July 1871.

9202. (*Chairman.*) I believe you have taken an active part in promoting the establishment of the College of Physical Science at Newcastle which has just been formed?—Yes, I have.

9203. Has your experience of the district led you to form a very decided opinion as to the importance of such an institution being established in that district?—Most decidedly so.

9204. What are the objects that you have had chiefly in view in promoting the establishment of this College?—The diffusion of scientific knowledge generally. There is almost a total absence of such knowledge amongst persons who are engaged in manufactures, mines, agriculture, and so on; and it is quite manifest that by communicating to those persons scientific knowledge you will enable them to work in the light instead of working in the dark, as they are at present; all their practice being rule of thumb work.

9205. Would that description apply almost universally to those engaged in the manufactures of the district?—I think so; certainly to engineering, to all chemical manufactures, to mining, and to agriculture. In fact, it is difficult to say to what it would not apply.

9206. What is the kind of education which hitherto the foremen and managers of the more important manufacturing works have received?—No scientific education at all; nothing but a mere primary education. It is impossible to make yourself understood by an ordinary foreman if you attempt to express yourself in scientific language.

9207. Do you contemplate that if the College succeeds in the way that you would desire, the greater part of the foremen and managers would be trained in the College?—I think they would then be selected from persons who had been trained in the College, or, at least, for the most part.

9208. At what age do you think it is desirable they should enter the College?—As soon after they have received their ordinary school education as possible, but I imagine that they might take up their studies even at a later period with great advantage. If it were practicable to give instruction in the evenings, then it would be open to artificers, and others, after they had entered upon their business pursuits.

9209. Do you contemplate having any entrance examination?—We have not discussed that, as yet.

9210. You have already appointed four professors, have you not?—Yes.

9211. And that, you think, will enable you to start the institution on a sufficiently wide basis?—To start it, certainly, but I think it is very desirable to extend it, if we could.

9212. Has the question been considered of making any application to the Government for assistance?—It has merely been referred to at our meetings.

9213. What is the view generally entertained upon that point?—My own view is, that we have a very sound claim upon the Government, considering how liberally the scheme has been supported locally. I think it would be a very fair thing if the Government, considering how much the nation benefits from the establishment of such colleges, in every case were to contribute a sum proportional to what has been raised in the locality towards the attainment of the object.

9214. You entertain no objections of any kind to receiving Government assistance?—Certainly not.

9215. I believe it so happens that at Newcastle you have buildings which are available, at least temporarily, for the purposes of the College?—Yes.

9216. If it succeeds, do you contemplate that ultimately it will be necessary to provide buildings appropriated solely to the College?—Yes, I think so, separate buildings altogether. We consider the present accommodation as a makeshift; but, without Government assistance, it would be scarcely possible to undertake that.

9217. Do you think that the feeling is spreading, or is becoming at all general amongst the chief employers of labour, that instruction of the kind that it is pro-

posed to provide in the College is becoming a matter of great importance?—Decidedly so, and I think that is evidenced by the very liberal contributions that have been made to this institution.

9218. Are you able to state whether any persons who have been educated at the Royal School of Mines in London are engaged in any of the branches of industry in your district?—No, I am not able to say. I do not know any instance myself, personally, but I think what we want is local colleges. London is far too distant; we want a college to be established in the locality, so that young men can attend it without going from their homes.

9219. Do you know any instances of young men who have gone up from your part of the country to London to take advantage of the education which they can obtain in the School of Mines?—No, I cannot call to my recollection any case.

9220. You are of opinion, are you not, that a college such as that which you have been establishing at Newcastle can tell more upon the industry of the district than it is possible for a college in London to do?—Infinitely more; in fact, I do not think that a college in London would have any practical effect in realising the object that we have in view.

9221. Then it is not simply instruction that is to be obtained, because that instruction can be obtained in London, can it not, as well as in the country?—What we want is the greatest possible facility of instruction near their homes.

9222. Do you contemplate that the sons of the great manufacturers will themselves take advantage of the course of instruction to be obtained in this college?—I think it is highly probable that they will. However, distance is not so much a consideration in their case, but if local colleges were equally as efficient as central ones, there is no question that they would be preferred by all classes.

9223. Do you agree with Mr. Bell, that the character of the instruction to be provided in this College should be mainly, or almost entirely, of a purely scientific character?—Certainly, because I do not think that there is any difficulty as regards other knowledge, but at present there is no means of acquiring scientific knowledge.

9224. What is your view as to any attempt to combine practical with scientific instruction in the College itself?—I think that practical knowledge is better acquired in the workshop and in offices, in actual business in fact.

9225. You would, therefore, not think it desirable that any workshop should be attached to the College?—No, I do not think so. You want the facility of acquiring theoretical information, such as can be applied to practice in actual business.

9226. At what age do young men usually obtain employment as foremen or managers?—Sometimes as soon as they are out of their apprenticeship, at 21, but that is a rare exception.

9227. At what age do young men usually become apprentices?—At about 15 or 16, more frequently 16, so as to be out of their time at 21; but I have known several instances, in our own works, of young men becoming foremen immediately on the expiration of their apprenticeship; but when they do that, they seldom stop at being foremen, they go still higher.

9228. Do you look to their passing through the College before they become apprentices?—We should do.

9229. Would the College course be got through as early as 16?—I should think mainly so, but I think it would be very desirable if they could continue their studies after they become apprentices; that is, in a degree, in the evenings. At our own factory we have night classes specially for the young men and apprentices.

9230. The work that they go through in the day is not so severe as to disqualify them from attending to instruction in the evening?—Certainly not; not to healthy young men.



Sir W. G.  
Armstrong.

11 July 1871.

9231. Do you contemplate having night classes in the College?—We hope so, if we can so arrange it.

9232. Would you consider that an important part of the system?—I think it is an important part.

9233. Chiefly, I presume, to meet the requirements of the young men employed during the day as apprentices, and so on?—Yes. We find, at Elswick, that a great number of our young men avail themselves of the night classes. We have there a mechanics' institute in combination with schools for primary education, and in this institute we have tuition in all branches of practical science in the evenings; and those who distinguish themselves at those classes never fail to be brought forward into the drawing offices, and so on. That may be considered as a test of what would be the case if they obtained similar instruction at evening classes at the College. People would naturally select those who had distinguished themselves, just as we do now those who distinguish themselves at those night classes.

9234. At the present time, do you give the preference to those who have a certain amount of scientific knowledge?—Yes, certainly; we are always on the look out for those who display any aptitude, and any superior progress.

9235. And you find an advantage in employing such men in preference to those who merely go upon the rule of thumb?—Yes, we are guided by our own interest in doing so; that is the principal inducement. Of course, one would naturally like to put forward deserving young men for their own sakes as well.

9236. Are you acquainted with what has been done on the continent in the way of training young men in science?—I have very little knowledge of what is done on the continent. I only know that local colleges of the nature of that which we are proposing at Newcastle are much more frequent on the continent than they are in England.

9237. (*Sir J. P. Kay-Shuttleworth.*) Some evidence has been given to us by practical men, for example by a partner in Mr. Platt's great machinery works at Oldham, as to the course of instruction which he had provided for his own son, and he stated that he would prefer to place him for a year or two, after leaving school, in the works, then to give him a couple of years' scientific instruction, than to take him back to the works, and then again to allow him to complete his scientific training. Would you think that some such practical work in a manufactory might be properly mixed in that way with pure scientific instruction?—I think, if we had nothing to consider but the education of the young man, it would be a very good thing, but I do not think that his employer would approve of that interruption of his duties.

9238. The obstacle would be within the works, that the proper value of his services would not in that way be obtained there?—I do not think it would.

9239. Hitherto, as we have been informed, the common course of instruction, excepting in such cases as your own works, has been that a young man has simply entered the office of an engineer, or a considerable manufacturer, and picked up what he could, in the ordinary routine of business, and so qualified himself to become afterwards a foreman, a manager, or a partner, and that without attaining any great scientific instruction. Is that in accordance with your experience?—Exactly so.

9240. The idea that this gentleman had was, that there was something in the very nature of the employment itself for which a young man might be unfitted, if he gave his mind for two or three years to purely scientific instruction, without being mixed up with the practical work of a workshop?—If he had become accustomed to mere practical employment, he would not readily take to theoretical study.

9241. If he had received, immediately after his purely theoretical instruction in school, a couple of years' course of scientific instruction, he might be in some degree unfitted for the roughness and dirt which he would encounter in manufacturing processes, and the contact with rough men, unless he had had some

previous experience?—There may be something in that. I think that young men at the Universities, at all events, are liable to acquire fastidious habits that do in some degree disqualify them for the rough life that they would have to lead in a workshop.

9242. This gentleman, a man who had himself risen from the ranks to an important position and to very great skill in the management of one very large department of Mr. Platt's works, expressed himself very strongly on the point which I am now bringing under your attention, namely, the importance of accustoming young men early to the labour which they would afterwards have to perform, before they entered upon a scientific course, and of giving them a practical aptitude and some experience of the form of life into which they would have to enter, before they became unfitted for it by the formation of more fastidious tastes?—I think it is very important that they should enter their business, whatever it is to be, at a tolerably early age, before their habits are too much formed. I think that is very important. I think that no man who is to battle with the world ought to be later than 16 or 17 in entering upon his employment, and, therefore, I think, whatever education is to be acquired should be mainly, at all events, before that. I think he can very easily keep up his studies, at his leisure, after that, provided that facilities are given. I hardly think that it would be desirable to draw him off from his business, and to interrupt his employment for the purpose of taking him a second time to the college. I scarcely think that that would answer—certainly not as a rule; it might do in particular cases, where it was desirable to complete the highest possible amount of scientific education.

9243. It might not be a bad course for a capitalist to train his own son, giving him those facilities, but you doubt whether for the ordinary rank and file of young men who are preparing for a profession it would be so desirable?—Pupils, for example, who pay a premium, and a liberal premium, on entering a factory, might pursue that course with advantage, and, of course, the premium would cover whatever disadvantage to the employer there might be, by taking a young man upon those terms.

9244. Abstractedly you would think, perhaps, that it is a course which a capitalist might pursue with advantage with respect to his own son?—Yes.

9245. And, also, wherever there was sufficient compensation made in the form of premium at the works in which the young man was employed?—Yes.

9246. In fact, that it is a preferable course, if there were not the impediment which you have pointed out?—I think probably it would be so.

9247. (*Professor Smith.*) I noticed that it is proposed to ask a fee of five guineas for each course of the Newcastle College?—Yes.

9248. Do you think that the amount of that fee is at all likely to exclude any persons?—I do not think it would; five guineas is quite within the reach of any well-to-do workmen, foremen, and so on. I think there would be few persons in that capacity, and upwards, but that would avail themselves of it, and whenever a young man really shows a great deal of talent at school, he generally finds somebody to help him a little.

9249. Are you satisfied with the arrangements that have been made for giving practical instruction in chemical and physical laboratories, where students must go to perform experiments?—We shall have to see that it is sufficient, but it is a matter which we shall have to look into. We have only just appointed a professor. There are a great many arrangements to make, and much to be completed yet.

9250. But you have the rooms at your disposal and funds for apparatus, have you not?—Yes. There is no doubt that we could make the College much more efficient if we had larger funds, and with that view a little Government aid would be very valuable. It is just as much as we can do to set it going by the means which we have at our disposal, and those means, I consider, represent a capital of fully 60,000*l.*



9251. (*Chairman.*) The annual income, for the present, will mainly be expended, will it not, in the stipends of the professors?—Yes.

9252. You think it of importance that the number of professors should be ultimately increased?—Certainly, ultimately.

9253. Have you at all contemplated making any application to the Government?—No, it has merely been the subject of conversation.

9254. You are able to make a beginning without Government assistance?—Quite so. We shall begin at once; in fact we have fixed to open in October.

9255. Are there any other points which you would like to name, connected with either the advantages that you anticipate from it or any other points?—No. I think the advantages are of a very general character, which must be perfectly obvious to everybody. I think there is a great want of such institutions all over the country, in all the great centres of manufacturing populations, and even in agricultural districts, because science is very intimately connected with the most advantageous mode of cultivating the ground; in fact, in every way whatever, the productive power of the country must be enormously increased where you can bring scientific knowledge to bear upon it.

The witness withdrew.

Adjourned.

9256. Have you any acquaintance with Owens College?—No personal acquaintance.

9257. That is, to a considerably greater degree, a place for general education, and not solely scientific?—No; but, as I understand, it was established chiefly with a view to scientific education. Unquestionably there is a great want of scientific education; you cannot get it anywhere hardly; certainly not from local sources.

9258. And you would like to see a considerable number of such colleges established throughout the country?—Yes, I think they ought to be in all manufacturing districts.

9259. Will you say that there was room for three or four of them in the northern districts?—There might be, say, one at Newcastle, and one at Leeds; you have already one at Manchester; and they might be scattered about in something like that proportion.

9260. Have any agriculturists given any encouragement to the College at Newcastle?—In some degree they have, but I do not think that they are so much alive to the importance of it as manufacturers are.

9261. Do you think that any of the larger farmers contemplate sending any of their sons there?—I have no doubt they will.

*Sir W. G.  
Armstrong.*

11 July 1871.







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APPENDICES.

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## LIST OF APPENDICES.

	PAGE
<b>APPENDIX I. (See Question 2.)</b>	
Proposed materials for the Seventeenth Report of the Science and Art Department of the Committee of Council on Education - - - - -	1
<b>APPENDIX II. (See Question 115.)</b>	
Parliamentary Votes for Science for the Middle and Upper Classes in 1867-8, exclusive of the cost of the Queen's Colleges in Ireland - - - - -	5
<b>APPENDIX III. (See Question 152.)</b>	
Confidential Memorandum with regard to the preparation of the Papers for the Science Examinations, May 1870. <i>Prepared for the use of the Examiners</i> - - - - -	6
<b>APPENDIX IV. (See Question 239.)</b>	
Science Form No. 331, respecting the Science Examinations of the Science and Art Department, South Kensington - - - - -	7
<b>APPENDIX V. (See Mr. Cole's Evidence, pp. 1-18.)</b>	
Extracts from Notes on Public Education, prepared at the desire of the Right Honourable Lord Robert Montagu, M.P., Vice-President of the Committee of Council on Education, South Kensington Museum, 28th of November 1867 - - - - -	8
<b>APPENDIX VI.</b>	
Correspondence between Her Majesty's Commissioners and the Heads of Colleges and Halls in the Universities of Oxford and Cambridge :	
I. Endowments and Parliamentary grants - - - - -	9-19
II. Heads of Colleges and Halls in the University of Oxford asked to give evidence - - - - -	19
III. Heads of Colleges in the University of Cambridge asked to give evidence - - - - -	22
IV. Information respecting Fellowships at the several Colleges in the Universities of Oxford and Cambridge - - - - -	25
<b>APPENDIX VII. (See Question 2891.)</b>	
List of Posts in Natural Science filled by men who have passed through the Physical Science Schools at Oxford - - - - -	31
<b>APPENDIX VIII. (See Question 2928.)</b>	
Letters from the Chairman of the Endowed Schools' Commission to the Vice-Chancellors of the Universities of Oxford and Cambridge - - - - -	32
<b>APPENDIX IX. (See Question 2949.)</b>	
Number of Students attending Science Classes during the Session 1869-70 - - - - -	33
<b>APPENDIX X. (See Question 5936.)</b>	
Form used by the Inspector of Science Schools conducted under the Science and Art Department - - - - -	38
<b>APPENDIX XI. (See Question 6188.)</b>	
Memorandum on the Progress of Scientific Instruction in Yorkshire by Henry H. Sales - - - - -	39
<b>APPENDIX XII. (See Question 5965.)</b>	
Analysis of Teachers of Science Classes in connexion with the Science and Art Department, 1869-70 - - - - -	41
<b>APPENDIX XIII. (See Questions 7129-7202, and 7779-7902.)</b>	
Aid given to Scientific Instruction and the Advancement of Science by the University of London and University College, London - - - - -	41
<b>APPENDIX XIV. (See Question 7483.)</b>	
Paper handed in by Professor Maskelyne - - - - -	43
<b>APPENDIX XV. (See Questions 7739-40.)</b>	
Paper handed in by Mr. Carruthers - - - - -	44
<b>APPENDIX XVI.</b>	
Extracts from the Reports for 1867 and 1868 of the Committee of Governors of the Worcester, Lichfield, and Hereford Training College, of which the Rev. Canon Gover is Principal - - - - -	47
<b>APPENDIX XVII.</b>	
Reports from Examiners under the Science and Art Department - - - - -	48
<b>APPENDIX XVIII.</b>	
Comparison of the Fees of Students and the Payments on Results in Science Schools under the Science and Art Department - - - - -	56
<b>APPENDIX XIX.</b>	
Minute of the Lords of the Committee of the Privy Council on Education on the Instruction given in the Schools of Science receiving Aid from the Science and Art Department - - - - -	57



# APPENDICES.

## APPENDIX I. (See Question 2.)

PROPOSED MATERIALS for the SEVENTEENTH REPORT of the Science and Art Department of the Committee of Council on Education.

### I.—AID GIVEN TOWARDS THE PROMOTION OF INSTRUCTION IN SCIENCE.

#### (a.) Elementary Scientific Instruction.

1. A satisfactory increase continues to be maintained in the number both of the Science schools and of the students under instruction in them from year to year, as will be seen from the following table of the returns from 1865 to 1869 :—

	No. of Schools.	No. under Instruction.
1865	120	5,479
1866	153	6,835
1867	212	10,230
1868	300	15,010
1869	516	21,500

In this table every institution in which scientific instruction is given is counted as a school, though the subjects taught and the number of classes in them vary much. In some instances a school consists of but one class, in which only one subject is taught, while in others there are 10 or more classes in different subjects. The 516 schools in 1869 comprised about 1,456 different classes. 12,988 students of these classes came up for examination in May, besides 246 self-taught students and pupils of classes not under certificated teachers. The results, as compared with those of the two previous years, are given below.

—	No. examined.	No. of Papers worked.	No. of Papers passed.	Prizes.
1867	4,520	8,213	6,013	3,453
1868	7,092	13,112	8,649	5,246
1869	13,234	24,085	14,550	1,969

At the examinations for seafaring men, held in March, September, and December, about 50 persons were examined in addition to the above.

2. The examinations were held in May at 437 centres, 389 provincial and 48 metropolitan. The payments to teachers on the results of instruction of the artisan classes, as tested by these examinations, amounted for the year 1869 to 17,015*l.* 15*s.*, being at the rate of 15*s.* 9*d.* for each person under instruction. In the previous year the rate was about 17*s.* 5*d.* The number of teachers paid was 486, the payments varying from 1*l.* to 236*l.* 10*s.*, the average being about 35*l.* per teacher. Grants were also made towards the purchase of apparatus, diagrams, and examples, amounting in the year to 357*l.* 15*s.* 5*d.*, being an increase of 21*l.* 13*s.* 0*d.* on the year 1868, when they amounted to 336*l.* 2*s.* 5*d.* Prizes and medals to the value of 711*l.* 18*s.* 8*d.* were awarded on the results of this examination.

3. The latest returns, March 1870, show that the number of Science Schools had increased to 810; of these, 561 were in England, 45 in Scotland, and 204 in Ireland. There were 2,204 classes in these schools, and the number of students taught in them was 29,956. This is an increase of 296 schools and about 9,000 students over the corresponding returns for the preceding year, and is irrespective of the Navigation Schools, which do not send up pupils for examination, and, therefore, receive no payments on results of instruction from the Parliamentary vote.

4. The first competition for the *Whitworth Scholarships* took place last May, and 106 candidates competed in the theoretical examination. Of these, 52 passed the qualifying examination, and 46 competed in the practical examination, which was held partly in London and partly in Manchester. In London, Messrs. Geo. Smith and Co., the eminent contractors, obligingly placed a portion of their workshops at our disposal for the practical examination; and in Manchester it was conducted at the works of the Whitworth Company. Sir Joseph Whitworth, Bart., under whose immediate superintendence the practical examination was conducted, expressed himself well pleased with the result.

Col. Rich, R.E., one of the Inspectors of Railways for the Board of Trade, Mr. W. P. Marshall, Secretary of the Institute of Mechanical Engineers, and Mr. W. J. Hoyle, Secretary of the Whitworth Company, were the examiners appointed, on Sir Joseph's nomination, for the practical examination. The rules adopted for the practical examination in 1869, having been found rather cumbersome and expensive, we have, with Sir Joseph Whitworth's concurrence, made some changes in the method of procedure, the details of which will be found at page 24 of the Appendix to the 17th Annual Report.

5. It is satisfactory to find that the Minute providing for the establishment of local exhibitions, elementary school scholarships, and science and art scholarships, is being largely taken advantage of, notwithstanding that a local contribution is now, in all cases, required as an absolute condition of aid from the Department. Towards a local exhibition the locality and the State contributes each 25*l.* Three local exhibitions were competed for last year, and 10 have been applied for, and will be competed for at the present examinations. Towards the Elementary School and the Science and Art Scholarships the locality contributes 5*l.*, which is supplemented in the former case by 5*l.*, and in the latter by 10*l.* Of the Elementary School Scholarships, 29 were competed for last May, and 65 will be competed for this May. Of the Science and Art Scholarships, 47 were competed for in 1869, and 62 will now be competed for. These several exhibitions and scholarships, which enable the poor student to remain at school and pursue his or her education, will no doubt have a good effect.

6. We think it only right to call attention to the great exertions of the Local Committees, on whose zeal in the carrying out of the system of State aid to science instruction so much depends. It is through their agency that the examinations are held in all parts of the country. More than 2,000 examinations were so held in 1869. When it is remembered that each examination entails the presence, generally, of three members of the committee from 7 p.m. till 10 or 11 p.m., and that the examinations take place in many districts night after night for eight or ten nights, and in some even oftener, the zeal and attention of the Local Committees will be appreciated. Mistakes and irregularities have in some cases occurred, as might be expected, from the novel nature of the duties to some of the gentlemen. The employment, however, of a large number of Officers of Royal Engineers as local inspectors has, as in the previous year, been of great service in assisting the Local Committees and seeing that the rules were strictly adhered to. In this way about 500 of the examinations were visited. Engineer Officers have also been this year employed in the preliminary inspection of Science Schools. Through their agency nearly the whole of the schools have been inspected and reported on. Besides enabling the Department to keep a check on the instruction given, the information contained in these reports has been of great service in facilitating the amalgamation of committees and schools for examination. This will effect a great saving, both in work and expense, to the central administration, and also diminish the calls upon the time of the members of the Committee.

7. In accordance with the provisions of the Minute of 11th March 1869 (see Appendix A., p. 27), advantage was taken of the teachers' visits to London to give them special instruction in the methods of teaching certain branches of Science. The instruction consisted of a course of lectures on the method of teaching Physiology in classes, by Dr. Michael Foster; a course on Light, by Dr. Guthrie; and one lecture and a short course of Laboratory practice by Dr. Frankland, at the Royal College of Chemistry in Oxford Street. Dr. Guthrie gave his course at the Royal School of Mines in Jermyn Street; Dr. Michael Foster, in the Lecture Theatre of the South Kensington Museum. The object of these courses was more especially to show easy and cheap methods of experimental demonstrations to classes. 253 students availed themselves of the lectures, 169 attended both courses; besides which, 35 attended the course on

Local Exhibitions, and Elementary and Science and Art Scholarships.

Effective co-operation of Local Committees

Inspection by Officers of Royal Engineers.

Teachers visits to London.



Light only, 49 that on Physiology only, and 153 attended the College of Chemistry.

8. Building grants were first extended to Science Schools in 1868. They have during the past year been sanctioned to Keighley and Burslem, and applications for grants to Lambeth, Southampton, Portsmouth, and Kendal are under consideration.

9. The appointment of special Local Secretaries for towns where there are many examinations appears to be working well. We trust by some further changes next year to reduce the labour of the Committees still more. Further details with respect to the Science Division will be found in the Report of the Official Inspector for Science, Captain Donnelly, R.E., at p. 45.

(b.) *Advanced Scientific Instruction.*

10. *The Royal School of Mines.*—The number of students attending the entire course of instruction for the diploma of Associate during the session 1868–69 has been 17, inclusive of the Royal Exhibitioners. This was an increase of five on the number in the previous session. Occasional students, to the number of 93, have attended one or more of the courses, the number in the session 1867–68 having been 102. The details of the attendance are reported by Sir Roderick I. Murchison, Bart., K.C.B., the Director, at page 463 of the Appendix.

11. *The Royal College of Chemistry* continues to be overcrowded, and suffers much from want of space. Dr. Frankland reports that he has been compelled to refuse admission to many applicants. The students' laboratory contains accommodation for only 40, at the most; but arrangements having been made for receiving into the Laboratory of Research some few of the additional candidates for admission, the return of the number of students for the three terms of 1869 presents an increase of 20 on the attendance in 1868; the respective totals being 116 and 136.

12. *The Metallurgical Laboratory* in Jermyn Street, under the direction of Dr. Percy, has been attended by 35 students during the session 1868–69, as against 29 in the preceding session; but the attendance at this Laboratory also is restricted by the want of adequate accommodation. The Reports of Dr. Percy and Dr. Frankland are embodied in that of the Director at pp. 464 and 466 of the Appendix.

13. *The Evening Lectures* to working men, at the Royal School of Mines, have been attended by as many persons as the Lecture Theatre will conveniently accommodate; the number of School Teachers attending the courses on Chemistry and Physics, specially intended for them, was 417, or 76 more than in the previous year.

14. *Royal College of Science of Ireland.*—The courses of systematic instruction in this College have been conducted, by the several Professors, in accordance with the programme appended to the annual report of the Dean of Faculty for the year 1868 (see 16th Report, p. 422). The Programme for the present session of 1869–70 (see App. p. 486) is the first in which the arrangements for the complete three years' course of instruction have been shown. The curriculum of study includes 14 subjects, and the total number of lectures delivered during the session ending June 1869 was 1,125. The number of individual students was 32, showing the material increase of 14 on that of the preceding session. The number of students pursuing the full three years' course for the diploma of Associate was the same as in the previous year, namely, 13. The results of the sessional examinations in 1869 are satisfactory; and one of the students subsequently gained a Whitworth Scholarship. Further information on this subject, and also respecting the museum of the College,—which has been visited during the year by 6,901 persons,—the Library, and the general administration of the Royal College of Science, will be found in the Report of Dr. Sidney, the Secretary, at page 497 of the Appendix. The Council express their confidence that, as the advantages of the technical training given in the Royal College of Science become more generally understood, the Institution will steadily progress in usefulness and popularity. (The Report of the Council will be found at page 485 of the Appendix.)

15. Courses of *Evening Popular Lectures on Science* were delivered by the Dean of Faculty and five of the Professors, at a fee of 6d. for each course. These lectures, which are entirely voluntary on the part of the lecturers, continue to be well attended; the total number of tickets taken in the past session have been 969 for the six courses. The evening course of Laboratory demonstrations in Practical Chemistry, intended for artisans and others employed during the daytime, was attended by 36 students.

16. *Royal School of Naval Architecture and Marine Engineering.*—The fifth session terminated on 30th April

1869. In consequence of the extension of the time for the course, as mentioned in our last report, from three to four years, there were few candidates for the Fellowship and Associateship among the students, and one candidate for the latter was admitted on the conditions laid down for those who wish to compete being already employed in the profession of Naval Architecture, or Engineering. No certificate was awarded. It appears from the report of the Inspector-General, the Rev. Joseph Woolley, LL.D., that sufficient time had not elapsed since this change to judge of its effect in improving the general character and amount of the knowledge of the students.

17. The privilege of attending the royal dockyards and factories was, as usual, accorded by the Lords Commissioners of the Admiralty to the private students during the four summer months from June to September, inclusive, with excellent results. The number of students during the session 1868–69 was 40, viz., 26 sent by the Admiralty and 14 private. The session 1869–70 commenced with 40 students, namely, 30 Admiralty and 10 private.

## II.—MEMORANDUM OF SUGGESTIONS for enlarging the System of State Aid to Scientific Instruction, drawn up in accordance with the Instructions of the Lords of the Committee of Council on Education prepared in 1867.

I.—The system and rules of the Science and Art Department for administering the grant for scientific instruction appear fairly to meet the requirements of one large class of persons. Sufficient aid is afforded, and encouragement thereby given to the elementary instruction in Science of the adult artisan class.\*

II.—The development that this system has at present taken has been almost entirely in creating evening classes.† Being a pure system of payment on results, however, it is quite possible under it for schools for boys of 10 to 15 years of age to flourish, and to earn large payments, as, for instance, the Bristol Diocesan Trade School, the Bethnal Green Birkbeck School, and the Glasgow Secular School do; but, as yet, few such schools have sought this aid. The reason is obvious. Schools cannot combine State aid to elementary and science instruction. It is only in large towns, and under peculiar circumstances, that day schools wholly devoted to secondary instruction can exist. Their establishment must be a work of time. The action of the Department has, therefore, been principally confined to promoting evening instruction in Mechanics' Institutions, and such places. Though payments are not made for the instruction of middle-class students, their instruction has incidentally been aided and encouraged by the establishment and existence of these classes affording them opportunities of instruction which did not exist before. Between 12 and 13 per cent. of the students in science classes, at present, are middle-class students.

III.—There remain two—as far as the machinery of education is concerned—broad classes but slightly affected by the present system of State aid to instruction in science. These are the younger artisan class—broadly the children of the weekly wage class—before they leave school, say of from 10 to 14 years of age; and the younger middle classes—the sons of the employers of labour and so forth, who are eventually to have the management and direction of works—before they leave school.

IV.—There can be no doubt that to meet the requirements of the day it is essential that there should be a more or less general diffusion among all classes engaged in productive industry of scientific, or, as it is sometimes loosely called, technical instruction—scientific instruction, that is; taken up from the point of view of its future application to industry, and not as a purely educational system.

V.—To meet the wants of the younger artisan class it appears to be only necessary to remove some existing restrictions‡ which prevent payments being earned for instruction in science given during the three attendances of

\* The progress of the Science Schools since the passing of the general Science Minute, June 1859, is shown in the following table:—

	No. of Schools.	No. under instruction.
1860	9	500
1862	70	2,543
1864	91	4,006
1866	153	6,835
1867	212	10,230
1868	300	15,010
1869	516	21,500
1870	810	29,056

The 212 schools in 1867 had 560 classes in different subjects. Of the 10,230 persons under instruction, 4,520 came up for examination, besides 400 persons not taught in classes aided by the Department. 8,437 papers were worked; 6,120 were passed.

† During the last two years, the training colleges have availed themselves pretty freely of the aid offered by the Department. The payments to them last year (1869) were 1,889l. This year the amount will probably be greater.

‡ Section XLIV. of the Science Directory.

Building grants.

Special Local Secretaries.

Royal School of Mines.

Royal College of Chemistry.

Metallurgical Laboratory.

Popular Lectures.

Royal College of Science of Ireland.

Increased number of students.

Museum and Library.

Progress of the College.

Evening lectures.

Royal School of Naval Architecture.



an elementary school receiving aid. This restriction was imposed when the schools were aided under the old system, which, it was considered, justified and required some check of this kind. If teachers of elementary schools were permitted to earn payments for the instruction in science, as in drawing, of the more advanced students in these schools, the results of the present science system show conclusively that they would very soon form such classes, and would induce a considerable per-centage of the parents to allow their children to remain longer at school.

VI.—Probably, it would be advisable that the payments should be made through the Education Department, who would then have full control of the matter. The Science and Art Department, acting according to its present system, would simply have to make a return of the results of the examinations to the Education Office.

VII.—To meet the requirements of these schools, it would be advisable to have a sixth standard of examination above the present fifth class, and to make a payment of 10s. on passing it. Whether it would be advisable to make any restriction as to the subjects of instruction, or not, is doubtful. It is generally better to leave this to work itself out.

VIII.—It has not been the policy of the State in this country to aid or interfere with the education of the middle classes, except to some slight extent, and that indirectly, by State endowments in colleges.\* The general opinion of the country, working through the Schools' Enquiry Commission and such agencies, can alone be looked to to make any important change in the way of introducing the study of science. Nothing, however, can have much effect on the grammar schools and middle-class schools of the country generally, until the Universities, which give the key of education in the country, allocate a fair proportion of their endowments to the reward of scientific studies. Till such knowledge "pays" at the Universities, the middle-class schools, which look more or less to them, cannot be expected to change their courses of instruction.

IX.—Should it, however, be considered good policy for the State to intervene more than it does at present in furthering scientific instruction among the middle classes, it would appear far more judicious to use existing machinery than to establish new. Money granted as endowments among the Universities and Colleges of the country would be more economically and effectively expended than in the creation of special State institutions.

X.—The instruction in the primary schools can, of course, only be of an elementary character. That in the adult night classes, though in some cases carried a little further, for want of time, means, and apparatus, cannot go to any depth. Such instruction, generally diffused, is of the greatest use; but it only goes far enough to warn people of the mistake they may fall into from sheer ignorance; to teach them not to be satisfied with mere empiricism; to show them how science may be applied to their work; and to induce them to follow it up.

XI.—The question then arises of providing instruction of a far more advanced character. The application of science to the arts can only be made by those who have a thorough knowledge of special branches. The masters, foremen, and others, who will take it up in this way, are necessarily but a small per-centage of those engaged in industry. Any of the poorer classes who show a special ability and aptitude for science can only follow it out if supported while pursuing their study. The richer classes can pay for their instruction. It is only necessary to provide the opportunity. Whatever the Universities and higher educational establishments of the country may do to afford instruction in science, the science will only form one portion of a general course of education. It would be foreign to their objects to afford advanced instruction in one special branch of science, and to grant diplomas to men who had not time or did not wish to pursue other studies, and whose general education was possibly very slight.

XII.—It is not, in the least, necessary that the institutions for giving this instruction should be spread about in country towns. The schools and classes attended by artisans at work, and boys living at home, can only be effective according as they are widely spread. But when it comes to the student's devoting his whole time, and being supported, it may as well be done in London as in Manchester, or Birmingham; and, besides the advantages of accessibility, etc., the best instruction can only be obtained in the capitals.

XIII.—A College of Science has lately been created in Ireland. The course of instruction, which lasts three years, is general, during the first two years, for all the students. During the third year it is specialized under the heads of

Agriculture, Mining, Engineering, and Manufactures. In England the only public institution, besides the Royal School of Naval Architecture, for advanced scientific instruction, is the Royal School of Mines in Jermyn Street. It has not quite as large a staff of professors as the College of Science in Dublin.

XIV. There are now eighteen Royal Exhibitions to these institutions competed for at the May examinations of the Department. They are of the value of 50*l.* per annum, and are tenable for three years. Six, therefore, become vacant every year. The fees are remitted, and the 50*l.* goes to support the student. They are most eagerly competed for. The number might with advantage be increased, at all events in a few years.

XV. \*A very simple and, probably, effective extension of this action would be to allow that, wherever a locality raised funds to establish exhibitions to support deserving students in London or Dublin, the fees for instruction should be remitted for those students, and, perhaps, the local funds supplemented. Any place, Leeds for instance, organizing its system of elementary science classes in any way that suited its requirements, could then, for a few hundreds a year, support several of the most promising students here in London, where they would receive the best scientific instruction to be had anywhere.

XVI. The present constitution and the name, "School of Mines," prevent that institution from filling the position of an advanced school of general science effectually. At the same time, by far the larger portion of the scientific instruction given in it is general, and would form a course applicable to any industry. This is not known, and a proposition to send students there would, unless they were intended for mining, not be understood. The Royal School of Naval Architecture and Marine Engineering has not, as yet, any staff for instruction in Experimental Science. This instruction is given by lecturers appointed from year to year, and in a small temporary Chemical Laboratory. It is, therefore, most advisable that a College of General Science should be organized or constituted in London, on the plan of the Irish College of Science, to meet the requirements here indicated.

XVII. A change is most desirable in every way. It is greatly to be regretted that the admirable courses of lectures of the Professors at the Royal School of Mines are attended by so few students. Though the separate courses are in some cases fairly attended, there are only some five or six students entered, besides the Royal Exhibitioners, for the full course of the School, that is, for the Associateship. This must always be so. The field that a School of Mines applies to is but limited. It does not get known in the country, and even the separate courses are not taken that advantage of which one would suppose.

XVIII. In time it may be found desirable to establish a third College of Science in Edinburgh, and, perhaps, a fourth in the North of England. There is no call for these, however, at present.

XIX. Much is said about the necessity for technical instruction, and efforts will, no doubt, be made to induce the State to supply it. It becomes, therefore, necessary to consider how far, if at all, the State can take this up advantageously, as distinct from the general scientific instruction previously considered.

XX. This action is proposed from two rather different points of view. The one proposal is to have a technical school adapted to the staple industry of a place; the other, apparently, to teach trades which do not exist there, with the idea of their introduction.

XXI. Real technical instruction—the teaching of a trade or art itself on scientific principles—necessarily entails workshops for practice. It would be scarcely possible to devise a more effectual blow to the manufacturers of a place than for the State to establish a really technical school for their trade, with its workshop, under no constraint to pay its expenses, underselling them and interfering with their market. A State pottery school and Messrs. Minton could not exist side by side. On the other hand, for the State to teach trades, where they do not exist, with the view of introducing them, and thereby most probably tempting them away from where they have established themselves, could, at the most, only be innocuous so long as it was ineffectual.

XXII. If, then, it were possible to keep pace with trade, the more efficient the schools were, the more injuriously would they affect private enterprise. It is, therefore, not necessary to dwell on the constant shiftings of trade,

\* This suggestion has since been carried out by the Minute of the 21st December 1867. See end.

† A Commission, consisting of Lord Granville, Sir C. E. Trevelyan, and Mr. Lowe, decided, in 1862, that the instruction in the Royal School of Mines should embrace only those branches of general science which are applicable to Mining, and that it should be a special Mining School, similar to those on the Continent.

\* Payments to Professors and Examiners, Exhibitions, Scholarships, Medals, and Prizes in the University of London, the Universities of Scotland, and the Queen's University and Colleges in Ireland.



according to the labour market, the difficulty of determining what was and what should be the staple industry of a place, and many other such points, which would render the administration of a system of technical schools an impossibility in this country.

XXIII. The only technical schools which the State can advantageously deal with are such as the Military Schools, the School of Naval Architecture and Marine Engineering, &c.,—that is, where it may be said to be instructing apprentices for the purpose of itself employing them partially or wholly.

XXIV. With regard to general industry, it may be taken that the action of the State cannot safely go further than by aiding and encouraging instruction in general science,—of such applied science as Mining and Metallurgy. The Commission for the College of Science for Ireland laid down that its aim should be to impart a sound and thorough knowledge of those branches of science which may be applied to industry, leaving it to the student subsequently to specialise his knowledge, and turn his attention in the direction he may find most suitable.

XXV. The system of payment on results is so well established, permits of such complete freedom of action, is applicable to such a variety of circumstances of schools, and has borne such good fruit, that I take it for granted it will not be proposed to alter it.

XXVI. As much pressure may, however, be brought to bear on the Government, it is, perhaps, right to point out, that the experience of this Department has proved nothing more decisively than that, in the conduct of science or art schools, any general joint action between the State and the locality is sure to lead to difficulties. Whatever system of guarantees for salary, &c., may be invented, the fact that the liability is really limited to one of the partners is sure to have its effect. It is impossible for the State to withhold the whole grant, and close up the establishment, after it has been in operation a few years, because the locality does not comply with every tittle of its contract; and so matters go getting worse from year to year. If pure payments on results cannot be wholly adhered to, care should be taken that the Department is only committed to some definite piece of work when the locality has fulfilled its portion, and that no continuous partnership is entered into.

XXVII. In conclusion, it is only necessary to point out that aiding instruction in science on the plan now being followed, with the proposed extension, can and will aid pure technical instruction in the very best way. That is to say, if the masters of works will either separately or in combination establish schools for the instruction of their employes, the State, by paying on the results of elementary and scientific instruction, would assist in the instruction of the students just 'up to the point of their learning the absolute trade. There is nothing to prevent manufacturers, with energy and public spirit, establishing as good schools as those of M. Schneider at Creuzot, and obtaining as much Government aid towards them.

J. F. D. DONNELLY, Captain R.E.

12th November 1867.

### III. SCIENCE INSTRUCTION.

- 1853. Department of Practical Art enlarged to Department of Science and Art.
- 1854. Science Schools proposed in Birmingham and Aberdeen. Teachers guaranteed Salaries.
- 1856. Commencement in Aberdeen, Bristol, Leeds, London, Newcastle, and Waterford, of Science and Navigation Schools. Examinations held and prizes awarded.
- 1859. Minute of 2nd June passed and first examination held in November for Science Teachers' Certificates. The only Science Schools existing at this time were at Aberdeen and Bristol, and these not largely attended; a few Navigation Schools were in operation.
- 1860. Nine Science Classes and 500 students under instruction.
- 1861. First May Examination held. Teachers paid on certificate allowance earned by results, with extra payments on all prizes awarded. 980 papers worked, about 650 individuals examined, and 1,330 under instruction in 38 schools.
- 1862. 70 Science Schools, and 2,543 under instruction.
- 1863. 75 Science Schools, and 3,111 under instruction. Payments on certificate allowance partially abolished.
- 1864. 91 Science Schools, and 4,666 under instruction. Payments on certificate allowance wholly abolished.
- 1865. 120 Science Schools, and 5,479 under instruction.
- 1866. 153 Science Schools, and 6,835 under instruction.
- 1867. November examination or certificates as teacher

abolished, first and second class in May being taken to qualify for earning payments on results. 212 Schools examined, and 10,230 individuals under instruction. Minute Establishing Local Exhibitions and Scholarships passed.

- 1868. Building grants to be made to Science Schools. Grants made to teachers visiting London. 300 Schools examined, and 15,010 individuals under instruction.
- 1869. Courses of Lectures and practical instruction given to Science Teachers by Prof. Huxley, Frankland, Guthrie, and Foster. First examination for Whitworth Scholarships. 523 Schools examined, and 21,500 individuals under instruction.
- 1870. 810 Schools examined, and 29,956 individuals under instruction.

### IV.—SCIENTIFIC INSTRUCTION.\*

#### LOCAL AND CENTRAL SCHOLARSHIPS.

*At Whitehall, the 21st day of December 1867.*

By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education.

Present.—His Grace the Duke of Marlborough, Lord President of the Council. The Right Hon. The Lord Robert Montagu, M.P., Vice-President of the Committee of Council on Education.

My Lords consider the subject of scientific instruction with a view to its further encouragement and diffusion.

1. They refer to the Science Directory of the Science and Art Department, and to the Minute of the Education Department of the 20th February 1867, making additional grants for secular instruction to elementary schools.

2. In order to assist the artisan classes who may show an aptitude for scientific instruction, my Lords resolve to aid local efforts in founding Scholarships and Exhibitions. The Scholarship is intended to maintain the student while remaining at the elementary school, and the Exhibition to support him while pursuing his studies at some central institution where the instruction is of a high grade.

3. *Local Scholarships.* These are of two kinds, the Elementary School Scholarship and the Science and Art Scholarship.

4. *Elementary School Scholarships.* The Science and Art Department will make a grant of 5*l.* towards the maintenance of a deserving student to the managers of any elementary school who undertake to support him for one year, and subscribe also at least 5*l.* for that purpose.

5. *Conditions.*—

- a. With any number of scholars up to 100 on the register of the school there can be but one such Scholarship; above 100 and up to 200 two Scholarships, and so on for each 100.
- b. The Scholarship or Scholarships must be awarded in competition to the most successful student or students in some examination of the school. The absolute terms of the competition and the award of the Scholarship will be left to the managers of the school, subject to the approval of the Science and Art Department.
- c. The scholar must be an artisan or poor student as defined by the Science Directory, and be between 12 and 16 years of age.
- d. He must not be the teacher, pupil teacher, or other paid servant of a school.
- e. He must continue regularly to attend the day school, and—
- f. Pass in some one or more branches of Science at the succeeding May examination of the Science and Art Department, after which the Department grant of 5*l.* will be paid.
- 6. These grants will be made from year to year on the condition that the student each year passes in a new subject, or in a higher grade of the same subject in which he first passed. It will be for the locality to determine for how many years the student may hold the scholarship, but in no case can he be allowed to hold it for more than three years.
- 7. The Science and Art Department will hereafter consider such alterations in these conditions as appear necessary.
- 8. *The Science and Art Scholarships.* The Science and Art Department will make a grant of 10*l.* towards the maintenance of a student at an elementary school who has taken a first grade in Freehand or Model Drawing and Elementary Geometry (see Art Directory), and passed in one of the subjects of Science (see Science Directory).
- 9. *Conditions.*—
- a. With any number of scholars up to 100 on the register of the school there can be but one such

\* Science Form, No. 275. South Kensington, December 1867.



scholarship, above 100 and up to 200, two scholarships, and so on for each 100 scholars.

- b. The scholarship or scholarships will be awarded to the most successful student or students in the school.
- c. The scholar must be an artisan or poor student, as defined by the Science Directory, of between 12 and 16 years of age.
- d. He must not be the holder of an Elementary School Scholarship, the teacher, pupil teacher, or other paid servant of a school.
- e. He must continue regularly to attend the day school, and—
- f. Obtain at least a third class in the subject of Science in which he has already passed, or pass in some other subject.
- g. In each year of holding the Scholarship he must pass either in a higher grade of the same subject, or in a new subject.

10. *Local Exhibitions.* The Science and Art Department will make a grant of 25*l.* per annum to the managers of any school or educational institution, or any local committee formed for the purpose, who will raise the like sum by voluntary contribution for the maintenance of a student at some college or school where scientific instruction of an advanced character may be obtained. The exhibition may last for one, two, or three years.

# 11. Conditions.—

- a. The exhibition must be awarded in competition in one or more branches of science at the May examination of the Science and Art Department. The managers may select any branch or branches of science for the competition, and if more than one be taken they may fix any relative amount of marks they consider best to assign to them.
- b. The place where the student is to pursue his studies may be fixed by the managers, subject to the approval of the Science and Art Department. If a Government institution be selected, such as the Royal School of Mines or Royal College of Chemistry, London, or the Royal College of Science, Dublin, the fees of the student will be remitted.
- c. The exhibitor must be of the artisan class, or a poor student as defined by the Science Directory.
- d. The grant of the Department will be paid from year to year, on condition that a like payment has been made by the managers or local committee, and that the student has pursued his studies satisfactorily according to regulations fixed by the Department.
12. Transmit a copy to the Treasury, and request sanction to provide in the estimate for the increased expenditure likely to be occasioned by this Minute.

Note.—By elementary school is understood any school where elementary instruction is given, whether aided by the State or not.

## APPENDIX II. (See Question 115.)

PARLIAMENTARY VOTES for SCIENCE for the Middle and Upper Classes in 1867–8, exclusive of the cost of the Queen's Colleges, Ireland.

### UNIVERSITY OF LONDON.

	£	s.	d.	£	s.	d.
Two examiners in Mathematics and Natural Philosophy, 200 <i>l.</i> each - - - - -	400	0	0			
Two assistant examiners in Mathematics, 50 <i>l.</i> each - - - - -	100	0	0			
Two examiners in Chemistry, 175 <i>l.</i> each - - - - -	350	0	0			
Two assistant examiners in Chemistry, 25 <i>l.</i> each - - - - -	50	0	0			
Two examiners in Experimental Philosophy - - - - -	200	0	0			
" " Botany, 75 <i>l.</i> each - - - - -	150	0	0			
" " Geology, 75 <i>l.</i> each - - - - -	150	0	0			
" " Physiology and Zoology, 150 <i>l.</i> each - - - - -	300	0	0			
				1,700	0	0

### UNIVERSITY OF ST. ANDREW'S.

Professor of Natural Philosophy - - - - -	150	0	0			
" Mathematics - - - - -	109	0	0			
" Chemistry - - - - -	125	0	0			
				384	0	0

### UNIVERSITY OF ABERDEEN.

Professor of Chemistry - - - - -	40	8	8			
Assistants - - - - -	150	0	0			
Professor of Botany - - - - -	300	0	0			
				490	8	8

### UNIVERSITY OF GLASGOW.

Professor of Mathematics - - - - -	62	0	0			
Assistant - - - - -	100	0	0			
Professor of Natural Philosophy - - - - -	21	0	0			
Assistant - - - - -	100	0	0			
Professor of Natural History - - - - -	200	0	0			
" Chemistry - - - - -	200	0	0			
Two assistants - - - - -	200	0	0			
Professor of Botany - - - - -	100	0	0			
" Civil Engineering and Mechanics - - - - -	275	0	0			
				1,258	0	0

### UNIVERSITY OF EDINBURGH.

Professor of Mathematics - - - - -	80	0	0			
Assistant - - - - -	100	0	0			
Professor of Natural Philosophy - - - - -	180	0	0			
Assistant - - - - -	100	0	0			
Professor of Natural History - - - - -	160	0	0			
" Botany - - - - -	160	0	0			
" Chemistry - - - - -	200	0	0			
				980	0	0
				£4,812	8	8

The amounts to each class of subjects were as follows :—  
MATHEMATICS.

	£	s.	d.	£	s.	d.
University of London - - - - -	500	0	0			
" St. Andrew's - - - - -	109	0	0			
" Glasgow - - - - -	162	0	0			
" Edinburgh - - - - -	180	0	0			
				951	0	0

### CHEMISTRY.

University of London - - - - -	400	0	0			
" St. Andrew's - - - - -	125	0	0			
" Aberdeen - - - - -	190	8	8			
" Glasgow - - - - -	400	0	0			
" Edinburgh - - - - -	200	0	0			
				1,315	8	8

### NATURAL AND EXPERIMENTAL PHILOSOPHY.

University of London - - - - -	200	0	0			
" St. Andrew's - - - - -	150	0	0			
" Glasgow - - - - -	121	0	0			
" Edinburgh - - - - -	280	0	0			
				751	0	0

### BOTANY.

University of London - - - - -	150	0	0			
" Aberdeen - - - - -	300	0	0			
" Glasgow - - - - -	100	0	0			
" Edinburgh - - - - -	160	0	0			
				710	0	0

### GEOLOGY.

University of London - - - - -	150	0	0			
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### PHYSIOLOGY, ZOOLOGY, AND NATURAL HISTORY.

University of London - - - - -	300	0	0			
" Glasgow - - - - -	200	0	0			
" Edinburgh - - - - -	160	0	0			
				660	0	0

### MECHANICS AND CIVIL ENGINEERING.

University of Glasgow - - - - -	275	0	0			
				£4,812	8	8

No annual reports are made to Parliament of the results of this expenditure.

Mathematics, natural philosophy, natural history, chemistry, mineralogy and geology, engineering, agriculture, anatomy and physiology, and political economy, are taught in the Queen's Colleges of Belfast, Cork, and Galway.



## APPENDIX III. (See Question 152.)

CONFIDENTIAL MEMORANDUM with regard to the Preparation of the Papers for the Science Examinations, May 1870.

*Prepared for the use of the Examiners.*

I. There are to be three papers in each subject.\*

- a. An elementary or first stage paper.
- b. An advanced or second stage paper.
- c. An honours paper.

The examination—except in subjects II. and III.—lasts three hours, from 7 p.m. till 10 p.m.

II. The successful candidates in the *elementary* paper, and the successful candidates in the *advanced* paper, are each divided into 1st and 2nd class, for which the teacher receives 1*l.* and 2*l.* respectively.

III. The *honours* paper is for highly advanced students—teachers and candidates for the Whitworth and other scholarships. The course of instruction may be considered beyond that of the science classes generally. Payments of 4*l.* and 2*l.* are made on account of students taking honours. The successful candidates are divided into 1st and 2nd class, and ranged in the order of merit.

IV. It is intended that all students shall come up in the elementary paper before they come up in the advanced. It is not possible to enforce this rule universally, as it would interfere with the competition for the Whitworth and other scholarships by outsiders. But everything is done to induce, if not to compel, students to take the elementary stage first. No prizes are given to a student, however well he may do in the advanced paper, unless he have previously passed in the elementary paper, and the teacher loses a chance of further payment. Therefore, it may be taken for granted that the great bulk of the candidates—all the students of science classes—will come up in the elementary paper first.

V. The *elementary paper* is, then, for first year, and second year, and possibly some third year students—lads of 13 and 14, and artisans who attend classes during the winter evenings.

VI. A teacher should be certain of passing a fair, even a large, proportion of moderately stupid students whom he had taught well during the winter (say giving them 30 or 40 lessons), in the 2nd class. The 1st class should be within the reach of a well-taught, clever, first year student, or an average second year student.

VII. The elementary paper will, therefore, have to cover a wide range, and, while it is in parts so easy as to give a student with a small amount of knowledge a chance of showing it, it will have to be sufficiently difficult in other parts to prevent the higher candidates from thinking that they can take the difficult paper the first year.

VIII. It must be remembered that the main object of this examination is to award the payments to the teacher on his year's work, by finding out the amount of really sound instruction he has given to each pupil. It is, in fact, not so much to find out what a pupil does not know as what he does know, by giving him every opportunity of showing it. The examination is, therefore, of a different nature to the ordinary examination of a school or class, all the pupils of which have had the same instruction, when the object is simply to find out those who have profited most. It is, therefore, advisable to set more questions in the paper than the student can, or is called upon to, answer, so as to give him a choice. Thus, supposing eight questions is the number a candidate may fairly answer in three hours, to set twelve, restricting the candidate from attempting more than eight.

IX. If questions of varying degrees of difficulty be given, as will probably be the case, and if different values be attached to them, it is essential the student should know these relative values, otherwise, by taking the wrong questions, he may, however well informed, not do himself justice. There are no doubt objections to this arrangement, as tempting the student to try questions beyond his power. But it is so desirable, in order to assist teachers who are bringing up students year after year, to indicate, by marks, the questions which the higher students should take, that it is necessary to disregard these objections. It is of more consequence to enable a good student to make certain of a first class, than to protect a foolish one from his own ignorance in attempting questions beyond his knowledge.

X. The following arrangement is not applicable to all subjects, but, where it is applicable, it is of great use in preventing cramming, viz., to set a few, say three, questions in the fundamental portions of a subject which all candidates must attempt, and to set a certain number of others from

which they may make a selection; to lay down, in fact, that of the eight questions which a candidate may attempt, three *must* be the first three in the paper, while the other five may be selected from the remaining questions.

XI. The same forms cannot, however, be equally applicable to all the subjects, and each examiner can modify the general instructions sent herewith.

XII. The *advanced* paper should be, if I may so say, a year in advance of the elementary paper, and a power of selection of questions is, perhaps, not so necessary.

XIII. The *honours* paper should certainly be a very "stiff" one.

XIV. It has been decided, in future, to count the absolute marks obtained by a student in the examination in the various competitions for Royal Exhibitions, Whitworth scholarships, &c.; and the following scale has been published:—

The maximum number of marks obtainable in each subject, except Mathematics, will be, in the—

Elementary stage	-	-	100
Advanced stage	-	-	200
Honours	-	-	400

In Mathematics the numbers will be, in the—

1st stage	-	100	
2nd "	-	200	
3rd "	-	300	Honours 500
4th "	-	150	
5th "	-	300	Honours 500
6th "	-	200	
7th "	-	400	Honours 600

But, in each case, the number of marks gained in the elementary stage (or in the 1st stage in Mathematics) will be diminished by the minimum number required to pass in that stage, and the number of marks gained in the other stages will be diminished by 20 per cent. of the marks obtainable in that stage. The remainder will then be added together to determine the candidate's position.

XV. In order to carry out this plan, it is absolutely necessary that the same *form* of paper should be adopted by all the examiners: that in each stage—Elementary, Advanced, and Honours—the candidate should be restricted to a certain number (*n*) of questions, as many as can be fairly answered in the time; and that to the (*n*) highest questions a maximum of 100 marks should be assigned. It is essential to limit the number of questions to be answered, otherwise a few quick students make a large number of marks and render it impossible to take a regular per-centage scale.

J. F. D. DONNELLY,

8th March 1870. Capt. R.E.

N.B.—It is, I am afraid, becoming the practice with some teachers to make a careful study of the examiner's manner and previous papers, and then to teach candidates the answers to certain questions, they think will be asked, by rote. I point this out, because, I believe, if warned, examiners may, by taking great care and varying the *form* of their questions, to some extent, check this most objectionable practice, without at the same time making their questions too difficult or "catchy." It would also, I think, conduce much to this end if in those cases where examiners have assistants, they consulted one or two of them on the subject when preparing their papers.

Science Form, No. 341.

SCIENCE AND ART DEPARTMENT of the COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

SCIENCE EXAMINATIONS.

CONFIDENTIAL MEMORANDUM on the appointment of Assistant Examiners, distribution of work, and examination of papers, prepared from Minutes of the Lords of the Committee of Council on Education, and other documents, for the use of the Examiners and Assistant Examiners for the Examination of 1870.

1. The result of each examination, however large, should be published not later than one month after its completion.



The revision of the papers by the examiners, therefore, should be completed in *three weeks*, at the most, as a full week must be allowed for transcribing, revising, and printing the lists.

2. To enable them to carry this out, the examiners, in those subjects in which there are many papers, have been requested to nominate, for their Lordships' approval, one assistant for every 1,000 written, or 1,300 *drawn*, papers.

3. The assistants to examine and work the papers allotted to them in 15 or 16 clear days, *at the outside*.

4. When the papers are ready for them, the examiners to meet their assistants at South Kensington, and to give precise instructions as to the scale of marks to be adopted, the kind of answering required, &c. The papers to be then divided amongst them in the proportion indicated in § 2.

5. When there are several assistants in a subject, a second meeting to be held, at the end of the first week after the examination, for the purpose of revising and comparing work, and of enabling each assistant to see the marks awarded by his colleagues, so that uniformity of marking may be maintained throughout the entire series of papers.

6. The examiner to be generally responsible for the whole examination, to examine all the *honours* papers himself, and to revise say 20 per cent. of the papers examined by his assistants, so as to keep a general check on the scale of awards and mode of working.

7. There are to be three papers in each subject.\*

- a. An elementary or first stage paper.
- b. An advanced or second stage paper.
- c. An honours paper.

The examination—except in subjects II. and III.—lasts three hours, from 7 p.m. till 10 p.m.

8. The successful candidates in the *elementary* paper, and the successful candidates in the *advanced* paper, are each divided into 1st and 2nd class, for which the teacher receives 1*l.* and 2*l.* respectively.

9. The *honours* paper is for highly advanced students, teachers, and candidates for the Whitworth and other scholarships. The course of instruction may be considered beyond that of the science classes generally. Payments of 4*l.* and 2*l.* are made on account of students taking honours. The successful candidates are divided into 1st and 2nd class, and their names are printed in the *order of merit*.

10. It is intended that all students shall come up in the elementary paper before they come up in the advanced. It is not possible to enforce this rule universally, as it would interfere with the competition for the Whitworth and other scholarships by "outsiders." But everything is done to induce, if not to compel, students to take the elementary stage first. No prizes are given to a student, however well he may do in the advanced paper, unless he have previously passed in the elementary paper, and the teacher loses a chance of further payment. Therefore, it may be taken for granted that the great bulk of the candidates—all the regular students of science classes—will come up in the elementary paper first.

11. The *elementary paper* is for first year, and second year, and possibly some third year students—lads of 13 and

14, and artisans who attend classes during the winter evenings.

12. A teacher should be certain of passing a fair, even a large, proportion of moderately stupid students whom he has taught well during the winter (say, giving them 30 or 40 lessons), in the 2nd class. The 1st class should be within the reach of a well-taught, clever, first year student, or an average second year student.

13. The *advanced* stage is intended to be a year in advance of the elementary stage.

14. The *honours* examination should be very "stiff."

15. The *absolute scale of marks to be taken for each class must depend on the amount of the parliamentary vote for "payment on results," and must be finally decided by the Committee of Council. But, at all events, at present, it will probably be taken as follows:—*

*In the advanced stage, above 74 per cent. 1st class.*

" " 39 " 2nd "

*In the elementary stage, above 69 per cent. 1st class.*

" " 29 " 2nd "

*It is hoped that this scale will, in fairly taught subjects, give, on an average, in the elementary stage, a first class to about one third of those who pass, and, in the advanced stage, a first class to about one fourth, or, perhaps, rather more, say two sevenths, of those who pass in that stage. The examiners are, therefore, requested to mark the papers so that, taking this scale, the result may, as far as possible, correspond with the intentions of §§ 12 and 13. The information at the head of the students' paper is to assist them in determining this.*

*The examiner need only write the total marks on each paper in the top right-hand corner.*

16. As the award of the Royal Exhibitions and of the Whitworth scholarships, as well as of numerous local prizes, exhibitions, and scholarships, depends on the results of this examination, it is absolutely necessary that the numerical value of each candidate's paper should be carefully given.

17. In computing the marks for the competitions, the maximum obtainable in the *elementary* stage has been fixed at 100; in the *advanced* stage, at 200; and in *honours*, at 400,—except in mathematics, for which there is a special scale.

It will be seen from § LV. p. 20 of the Science Directory, that, in the *advanced* stage, and in *honours*, a candidate may count marks, though he fail in securing a class, if he obtain more than 20 per cent. of the marks awarded for that stage. Whilst, therefore, the examiners can cut out all such papers as are evident failures, and such as, for gross faults, ought to be cancelled, they should carefully mark those in the *advanced* stage, or in *honours*, which get more than 40 and 80 marks respectively.

18. There is a disposition on the part of some teachers to make a careful study of the examiner's manner of questioning, and of the papers of previous years, and then to teach their pupils, by rote, the answers to questions which they think will be asked. It is very desirable that the examiners should, as far as possible, check this objectionable practice, by rejecting all such papers as are unmistakably the result of mere "cram."

19. A general report on the system of teaching, its faults, &c., from each Examiner would be of great use to the teachers.

J. F. D. DONNELLY,

May 1870.

Capt. R.E.

## APPENDIX IV. (See Question 239.)

Science Form, No. 331.

South Kensington, March 1869.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

At South Kensington, the 10th day of March 1869. By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education.

Read the following memorandum prepared by Captain Donnelly, R.E., in accordance with the instructions of My Lords:—

### SCIENCE EXAMINATIONS. MEMORANDUM.

1. The great increase in the numbers examined in May, renders a better organization than obtains at present necessary for looking over the papers, not only to ensure this being done in time, but also to reduce the expense. The large sum taken for examination in the estimates was commented on last year in the House of Commons.

2. By a proper organization of assistants both objects

may, I believe, be attained without sacrificing efficiency. Many of the subjects have been, for several years, so large that the examiners have had to employ assistants, with whom they have made their own arrangements. In future, in these large subjects, it would be better that the examiners should nominate their assistants for the approval of My Lords, and that they should be paid directly by this Department. It would, I believe, be more agreeable to the examiners, and would enable the Department to have a more definite organization.

3. The results of the examination in each subject should be published not later than a month after the examination, however large the subject may be.

4. To enable this to be done, the examiners must complete their work in three weeks at the outside, as one week is the least that can be allowed for transcribing, sorting, revising, and printing the lists.

5. From the inquiries I have made, I believe 70 written (three hour) papers are all that can be examined satisfactorily by one person in a day, or in six hours' work, and this only when many of them are short. In the drawing subjects, probably a third more can be done in the same time.

\* Except in Mathematics, in which subject there are seven stages.



6. There should, then, be an assistant for every 1,000 written, or 1,300 drawn, papers; for, deducting the time required for comparison, revision, &c., he would have to look through them in 14 or 15 days.

7. I would propose, then, that when the papers were ready, the examiner should come here and meet his assistants; that he should give them precise instructions as to the scale of marks to be given, the kind of answering required, &c.; and that, then, the papers should be divided amongst them, a record being kept of the papers that each takes away.

8. In a week, there should be a second meeting for revision and comparison, each assistant looking at the marks that the others were awarding, so that the same scale might be maintained, as far as possible, throughout.

9. At the end of a fortnight, a third meeting would be necessary for a general revision, and for making up the papers.

10. The examiner should *roughly* examine (say) 20 per cent. of the papers looked over by his assistants, so as to keep a general check on the scale of awards and way of working. This might be done by the assistants sending him their papers, through the Science and Art Department, as they went on.

11. The examiner should also look over all the *honours* papers himself, and be generally responsible for the whole examination.

12. I do not propose any change in the present system as regards the smaller subjects, nor to the examiners being, as now, appointed, or rather asked to act, from year to year.

13. The remuneration might be managed as follows:

- a. The examiner in one subject to receive a retaining fee of 50 guineas, in two or more subjects 100 guineas.

[This fee is not only for the work connected with the examination, but as a general retaining fee for the year; for it must be remembered that the examiner is constantly called on to attend meetings, write reports, and give his advice and opinion on a variety of subjects; in fact, to act as referee for the Department in the subjects in which he examines.]

b. For the preparation in May of the three papers in each subject—*honours, advanced, and elementary*—to receive 10 guineas.

c. For the examination of the *honours* papers to be paid, as now, at the rate of 30 shillings for 10 papers.

d. For each day's attendance here to meet the assistants, 3 guineas.

e. For the revision of assistants' work, at the rate of 1*l.* per 20 papers looked over.

14. The assistants' remuneration to be at the rate of 1*l.* 10*s.* and 1*l.* per 20 of the *advanced* and *elementary* papers respectively, and in the *drawing* subjects 1*l.* and 15*s.*; and 2 guineas a day for the days they attend here to receive their instructions, &c.

15. Though the payments may, at first sight, appear large, I would beg leave to point out that it is of the highest importance, both as regards the success of the teaching and the position of the Department, that the very best men should be employed in this work, which is of a very laborious and repulsive nature, and that the teachers, whose pay depends entirely on the examination, have a right to expect that it should be very well and very carefully done.

J. F. D. DONNELLY,  
Capt. R.E.

6th March 1869.

My Lords approve the same.

HENRY COLE.

## APPENDIX V. (See Mr. Cole's Evidence, pp. 1 to 18.)

EXTRACTS FROM NOTES ON PUBLIC EDUCATION, prepared at the desire of the Right Hon. Lord Robert Montagu, M.P., Vice-President of the Committee of Council on Education, South Kensington Museum, 28th November 1867.

### II. SECONDARY OR TECHNICAL INSTRUCTION.

10. I concur generally in the paper of 12th November 1867, which Capt. Donnelly has prepared on this subject.

11. I recommend that the managers of elementary schools be free to establish classes for teaching science through certificated teachers, and that payments on results be made to them, and that all fears of competition with elementary education be ignored. (See Education Minute of 20th February 1867.)

12. If effective measures can be taken to deal with the funds and management of the old Free and Common Grammar Schools, the teaching of art and science might be largely introduced into them without increased charge on Parliamentary funds.

13. I consider that the State might usefully establish professorships, with prizes and, perhaps, scholarships for science, at Eton, Harrow, Rugby, &c., as well as at the Universities. A very few thousand pounds expended annually in this direction would, I conceive, be the most efficient means of aiding technical instruction. Such an expenditure would act in increasing the public revenue in a few years. Until increased honours are awarded at the Universities for acquiring experimental science, and the knowledge is felt to be remunerative, experimental science will stand no chance with the study of classical learning; and the industrial position of this country, in comparison with other countries generally, will get from bad to worse. (Some parliamentary votes are already made to Universities for Science, see Estimates, Class IV.)\* The address of Mr. J. S. Mill, Rector of St. Andrew's, whilst fully estimating the great value of classical knowledge, shows the necessity for scientific teaching, in the most eloquent terms. It is a text book on the subject. (See also Mr. Lowe's address to the Philosophical Institution at Edinburgh.)

14. Four establishments should be formed in the nature of Training Colleges for teaching practical science. There is already one at Dublin. The School of Navigation and Science, now building at South Kensington, might be readily enlarged into such a college. Arrangements, I believe, might be made for a third, either in connexion with the University at Edinburgh, or at Glasgow. And a fourth might be created in the midland counties. The latter college, as well as that for Scotland, might be located in that place which offered to endow the greatest number of scholarships in it.

15. Capt. Donnelly's paper fully states the objections to state "trade" schools, so I do not repeat them.

\* Vide ut infra.

### III. PUBLIC LIBRARIES AND MUSEUMS.

16. Public Libraries, Galleries, and Museums should be viewed as the highest instruments of public instruction, and be rendered as effective as possible to that end. Full titles, inventories, and catalogues should be prepared, as well for the learned as the unlearned visitor. The superior manners and general culture of the mass of the people, especially in art and science, in many parts of Europe, are to be attributed to the influence of the greater number of public libraries and museums than with us, and to the facilities offered to all classes to study them.\* The British Museum, which possesses treasures of the greatest instructional value, is still somewhat treated in its management and purpose only as a collection of things "rare and curious," as they were defined by Sir Hans Sloane a century ago, and not as a great public educational institution, which it might be made.

17. I strongly recommend, both on religious and moral grounds, that arrangements be made, as at Kew Gardens and Museum, Hampton Court and Greenwich Picture Galleries, &c., to admit the public to National Institutions on Sunday afternoons. A more elevating measure could not be devised.

18. To render public libraries and museums, which are supported in the main by public funds, proper instruments of public instruction, and to manage them effectively and economically, it seems to me indispensable that they be placed under the sole responsibility of a Minister of the Crown. Numerous boards render executive management impotent, and are quite incompetent to deal with the proper expenditure of public funds. Boards are useful for counsel, but obstructive for action. On this subject, as well as on a better administration of public museums, public opinion has been maturing for more than thirty years. (See especially "Quarterly Review," No. 175, Dec. 1850; "Edinburgh Review," January 1866.)

19. The greater number of such public institutions of science and art are already under a ministerial authority. It would be of great public benefit, in every way, to subject the remainder to the same authority. (See Estimates, Class IV., Learned Societies.) But I allude especially to the British Museum, the National Gallery, the National Portrait Gallery, and the Patent Museum in London, also to the National Gallery and Royal Irish Academy in Dublin, and the National Gallery, Edinburgh.

\* See list of such institutions in France, &c., printed by the Department.

Elementary schools and science.

Free and grammar schools.

Upper grammar schools. Universities.

Public libraries, museums, and public instruction.

Sunday openings.

Ministerial Public Instruction.

Public museums, under ministerial public instruction.



## IV. GENERAL PRINCIPLES OF ADMINISTRATION.

20. I consider it necessary that elementary education, secondary or technical instruction, the management of public libraries, galleries, and museums, and *all* the votes given for education, science, and art, should be concentrated in their administration of them, so far as the expenditure of public funds at least is concerned, under the sole authority of the same Minister of the Crown.

21. This Minister of Public Instruction ought not, I venture to think, to be the Lord President of the Council. The work appears to me ample enough to engage the sole attention of a Minister, who, I also venture to think, ought to rank as a Secretary of State. He would sit in either House, according to the circumstances of the Cabinet. There should be an Under Secretary also in Parliament.

22. In my opinion, the present work at the Privy Council Office, with all the calls for charters, health,

cattle plague, quarantine, &c., made upon the attention of the Lord President, make it impossible for that high functionary to devote sufficient time to numerous questions involved in public instruction, viewed comprehensively.

23. To enlarge elementary education, making it truly national;—to reform the educational charities;—to increase technical instruction throughout the United Kingdom;—to reorganize the British Museum,\* the National Gallery, the National Portrait Gallery, &c., so as to make them work efficiently and harmoniously together, are functions which ought not, I conceive, to be treated as of secondary importance to any others.

(Signed) HENRY COLE.

\* In doing this, the Family Trustees should be kept, of course; but they should revert to their original functions; there should be no further elections of "elected trustees;" and the "official trustees" would at once give way to a single responsible Minister.

## APPENDIX VI.

## CORRESPONDENCE between HER MAJESTY'S COMMISSIONERS and the HEADS of COLLEGES and HALLS in the UNIVERSITIES of OXFORD and CAMBRIDGE.

## I. Endowments and Parliamentary Grants.

The following letter was addressed on the 13th June 1870 to the Heads of Colleges and Halls at Oxford and Cambridge:

Royal Commission on Scientific Instruction and the Advancement of Science,

6, Old Palace Yard, Westminster, S.W.

June 13th, 1870.

I HAVE the honour to inform you that Her Majesty has appointed Commissioners to make inquiry with regard to Scientific Instruction and the Advancement of Science, and to inquire what aid thereto is derived from grants voted by Parliament, or from endowments belonging to the several Universities in Great Britain and Ireland and the Colleges thereof, and whether such aid could be rendered in a manner more effectual for the purpose.

The Royal Commissioners are of opinion that the inquiry with which they are charged will be much facilitated by their being speedily placed in possession of authoritative statements, on behalf of the several Universities and Colleges indicated in their Commission, of the aid to scientific instruction and the advancement of science derived from Parliamentary grants and from endowments which they enjoy.

I am, therefore, directed to request that you will have the goodness to furnish the Commissioners with a statement of all sums applied to the advancement of science or to scientific instruction, in the University of

College, which are derived from endowments or from Parliamentary grants.

This information will be useful to the Commissioners in proportion as these endowments and grants and their applications are specified in detail.

I am further to state that the Commissioners will be glad to receive suggestions or to hear evidence from you in respect of the matters into which they are commanded to make inquiry.

I have the honour to be, sir,

Your obedient servant,

J. NORMAN LOCKYER,

Secretary to the Commission.

The following replies were received:—

## UNIVERSITY OF OXFORD.

20, Dean's Yard, Westminster,

July 27th, 1870.

THE Vice-Chancellor of Oxford has the honour of forwarding the accompanying return in compliance with the request of Her Majesty's Commissioners appointed "to make inquiry with regard to Scientific Instruction and the Advancement of Science," and regrets that unavoidable circumstances have caused so much delay in preparing the return:—

26060.

## RETURN of ANNUAL PAYMENTS for the ADVANCEMENT of SCIENCE in the UNIVERSITY of OXFORD.

Estimated from Amounts actually paid in the University Year 1868-9.

## Professoriate.

Professors.	Amount arising from Endowments.	Amount paid by the University.
	£ s. d.	£ s. d.
Astronomy, Savilian Professor of	272 12 2	162 19 0
Botany (Crown Grant)*	97 12 1	—
Ditto, Sherard's Professor	78 12 10	—
Ditto, Rural Economy, Sibthorp's Professor.	196 4 2	—
Chemistry, Waynflete Professor	—	—
Chemistry, Prælector of (Crown Grant)*	97 18 4	—
Ditto, Aldrichian Demonstrator of	126 8 0	—
Geology	—	390 16 8
Geometry, Savilian Professor of	272 12 2	162 19 0
Medicine, Regius Professor of	—	Fees on
		Presentations
Ditto, Aldrichian Professor of Practice of.	126 8 0	—
Mineralogy	—	97 12 1
Natural Philosophy, Sedleian	125 1 9	167 16 6
Physiology, Linacre Professor of	—	—
Ditto, Aldrichian Professor of Anatomy.	126 8 0	—
Ditto, Tomlin's Prælector of do.	88 4 8	—
Physics, Experimental	30 0 0	263 17 6
Zoology, Hope's Professor	390 16 8	—
	£2,028 18 10	£1,246 0 9

\* Paid by the University by composition with the Crown.

## Demonstrators' Assistants, &amp;c.

Chemistry, Waynflete Professor of, for a Demonstrator.	—	146 11 3
Ditto, for an Assistant	—	97 14 2
Physics, Experimental Professor of, for an Assistant.	—	107 8 0
Zoology, Hope Professor of, for a Servant.	—	15 0 0
Observatory, Radcliffe, for an Assistant.	117 7 6	—
	£117 7 6	£366 13 5

## Examiners.

Natural Science, Examiners in	—	146 11 3
Medicine, Examiners in	—	78 0 0
	—	£224 11 3



*Scholars, &c.*

	Amount arising from Endowments.	Amount paid by the University.
Geology, Burdett-Coutts -	165 12 5	—
Meteorology, Johnson Prize -	9 18 0	—
	£175 10 5	—

*University Museum.*

	£ s. d.	£ s. d.
Museum Annuity - -	—	645 0 0
Ditto, extra Grant - -	—	250 0 0
MUSEUM :		
Chemistry, Department of, for Apparatus.	—	150 0 0
Physics, Department of, for Apparatus.	—	250 0 0
Zoology, Department of, for the Collection.	48 17 1	—
Ditto, and garden rates and taxes	—	49 12 0
	£48 17 1	£1,344 12 0

*Botanic Garden.*

Botanic Garden, for repairs, &c. -	100 0 0	—
Ditto, for maintenance, &c. (Dr. Sherard).*	150 0 0	—
Ditto, ditto, Crown Grant* -	82 0 0	—
Fielding Herbarium - -	—	58 10 0
	£332 0 0	£58 10 0

\* Paid by the University by composition with the Founders.

NOTE.—No account is taken in this return of stipends or augmentations of stipend paid to Professors by several Colleges, or of the emoluments received by the Regius Professor of Medicine from Ewelme Hospital, or of payments from the Radcliffe Trust.

## SUMMARY OF ANNUAL PAYMENTS for the ADVANCEMENT of SCIENCE in the UNIVERSITY of OXFORD.

Departments of Scientific Instruction, &c.	Amount arising from Endowments.	Amount paid by the University.
	£ s. d.	£ s. d.
Professors - - -	2,028 18 10	1,246 0 9
Demonstrators' Assistants, &c. -	117 7 6	366 13 5
Examiners - - -	—	224 11 3
Scholars - - -	175 10 5	—
University Museum - - -	48 17 1	1,344 12 0
Botanic Garden - - -	332 0 0	58 10 0
Total - - -	£2,702 18 10	£3,240 7 5
Grand total - - -	£5,943 1 3	

NOTE.—Pure mathematics are not included in this return.

F. K. LEIGHTON, Vice-Chancellor.

E. T. TURNER, Registrar of the University.

## COLLEGES.

1. *University College.*

University College, Oxford,

August 6th, 1870.

SIR,

IN reply to your communication of the 5th inst., I beg to say that only one student of this College has attended the classes in which natural science is taught in the University during the session of 1869–1870, and that he obtained a place in the first class on the public examination in natural science in the Trinity term 1870.

I may add, that we have two or more scholarships in this College, which are given for proficiency in mathematics.

I shall be ready to give any further information which may be desired, if a communication is made to me in November or December next.

I am, Sir,

Your obedient servant,

F. C. PLUMPTRE, D.D.,

Master.

J. Norman Lockyer, Esq.,  
Secretary.

2. *Balliol College.*

Balliol College, Oxford,

June 14th, 1870.

SIR,

I HAVE the honour to acknowledge a letter from the Royal Commissioners on Scientific Instruction and the Advancement of Science, inquiring what sums are applied to the advancement of science or to scientific instruction in Balliol College, Oxford, which are derived from endowments or parliamentary grants.

From parliamentary grants we have none.

But Miss Hannah Brakenbury, of Adelaide Crescent, Brighton (who is still living), founded and endowed three scholarships at Balliol College a few years ago, which, in alternate years, are filled up by a competitive examination in natural science. The scholarships are tenable for three years. In the alternate years they are filled up by a competitive examination in law and modern history. The value of each of these scholarships is 70*l.* per annum, less income tax.

I have the honour to be, Sir,

Your obedient servant,

ROBERT SCOTT,

Master of Balliol.

Norman Lockyer, Esq.,  
Secretary, &c.

3. *Merton College.*

Caversfield, Bicester,

August 8th, 1870.

SIR,

I HAVE the honour to acknowledge the receipt of letters from you dated the 4th and 5th inst., the former containing a copy of the Aid to Science Commission, and inquiring whether I have any facts or suggestions to lay before the Commissioners with regard to Merton College, and asking if I would be prepared to aid the Commissioners in the prosecution of their inquiry by attending to give evidence in November or December next; the latter requesting a return of the number of students attending any classes in which science was taught during the session 1869–1870.

With regard to facts, I have to say that there is connected with Merton College an endowment by Linacre for 18 lectures in medicine and surgery annually, in respect of which a professorship, with a salary of 800*l.* per annum paid by the college, was established by an ordinance of the Commissioners in 1854, and that the college has lately promoted physical science by giving a preference to professors in that science to candidates for fellowships and scholarships in some instances.

As to suggestions, none occur to me at present; and I regret to say that, in consequence of the absence of the Tutors of the College, during the long vacation, I am unable to state the number of students attending classes in which science was taught during the session 1869–1870.

I shall have pleasure in furnishing the Commissioners with any further information in my possession, and in waiting on them in November or December, if required.

I have the honour to be, Sir,

Your obedient servant,

R. BULLOCK-MARSHAM,

Warden of Merton.

4. *Exeter College.*

Exeter College, Oxford,

June 27th, 1870.

SIR,

No money derived from parliamentary grants or from special endowments is applied to the advancement of science or scientific instruction by Exeter College, save, at least, under the following statutable direction:—

“Preference shall be given to those candidates in whom shall be found the highest moral and intellectual qualifications, such intellectual qualifications having been tested by an examination in such subjects as the College from time to time shall determine.”

One out of 15 fellows has been elected for mathematical knowledge, and another is to be elected for mathematical knowledge next week.

The College might, it will be seen, have elected for knowledge in natural science; and the subject of such an election was discussed, but a second mathematician seemed at the present moment more desirable.

I have the honour to be

Your obedient servant,

J. P. LIGHTFOOT,

Rector of Exeter College.

Norman Lockyer, Esq.,  
Secretary, &c.



5. *Oriel College.*

[See p. 20.]

6. *The Queen's College.*

Lowther Rectory, near Penrith,  
August 10th, 1870.

SIR,

I HAVE the honour to acknowledge the receipt of your letter of the 4th inst., which has been forwarded to me from Oxford.

In reply to your inquiry, whether I have any facts or suggestions to lay before the Commissioners with regard to Queen's College, I beg to state that I have no facts besides such as I believe are already before the Commissioners. The facts that I refer to are, that the only money payment out of the revenues of the College towards the advancement of science is 270*l.* paid yearly, as an addition to the salary of the Sedleian Professor of Natural Philosophy. This, however, although the only money payment, is not all that is done by the College for the advancement of science. The College statutes direct that the system of examination for fellowships shall be such as to render the fellowships accessible from time to time to excellence in every branch of knowledge recognized in the schools of the University, and we are in the habit of allowing candidates to choose the subjects in which they desire to be examined. The same rule, with respect to the choice of subjects, is observed in the examination for our open scholarships, so that, although no fellowship or scholarship is specially or exclusively set apart for any one subject, all our (19) fellowships and (15) scholarships may be said to be open to proficiency in science. One of our present fellows and one of our scholars were elected for proficiency in natural science; and I observe, that in the University examination for the degree of B.A., the first class, at the examination in Michaelmas term 1869, contained a greater number of names in the school of natural science than in any other school.

After this statement, perhaps the Commissioners may agree with me in thinking I could not be of any use in giving evidence; if, however, they think otherwise, I wish to put myself entirely into their hands, and will consider it my bounden duty to attend to any summons they may send me.

I have also before me your letter of the 5th. I am sorry I cannot return a strictly exact account of the number of students attending any science classes at one time during the last academical year, without reference to some papers which are in the hands of one of my College Tutors. I have written for the papers, and will send the information required as soon as I can. Begging you to excuse the unavoidable delay,

I have the honour to remain, Sir,  
Your faithful and obedient humble servant,  
WM. JACKSON,  
Provost.

J. Norman Lockyer, Esq.

7. *New College.*

New College, Oxford,  
June 14th, 1870.

SIR,

IN reply to your letter, I beg leave to inform you that there are no special endowments in this College for the advancement of science, or for scientific instruction, nor does the College receive any parliamentary grants for such purposes.

I have the honour to remain  
Your's faithfully,  
J. E. SEWELL, Warden.

J. Norman Lockyer, Esq.,  
Secretary, &c.

New College, Oxford,  
August 2nd, 1870.

SIR,

ON considering again the inquiry made in your letter of the 13th of June, on behalf of "the Commission of Scientific Instruction and the Advancement of Science," I think it necessary to state that, although there are no special endowments in this College by original benefactors for such objects, yet the general endowments of the College are charged with a payment of 600*l.* a year viz., 300*l.* to the Savilian Professor of Astronomy, and 300*l.* to the Savilian Professor of Geometry, by virtue of an ordinance framed by the Oxford University Commissioners in 1857.

At present half only of this sum is paid to each professor, under the terms of the ordinance. The other half will become payable in five years from Lady-day last.

I am, Sir,  
Your's faithfully,  
J. E. SEWELL,  
Warden of New College.

8. *Lincoln College.*

[See p. 20.]

9. *All Souls' College.*

SIR,

All Souls' College, Oxford.  
In reply to your printed circular of the 13th inst., I have the honour to inform Her Majesty's Commissioners that we have no endowments or parliamentary grants in this College restricted to the advancement of science, or to scientific instruction, though such is occasionally given from the College funds, for the assistance of Bible clerks who wish to devote themselves to that branch of education.

I have the honour to be, Sir,  
Your obedient servant,  
F. K. LEIGHTON.

J. Norman Lockyer, Esq.,  
Secretary, &c.

10. *Magdalen College.*

[See p. 20.]

11. *The King's Hall and College of Brasenose.*

[See p. 21.]

12. *Corpus Christi College.*

Corpus Christi College, Oxford,  
June 24th, 1870.

SIR,

IN reply to your inquiry, under date June 13th, I beg to inform you that in this College there is no endowment specially appointed for the advancement of science, and that no aid is here derived for that object from any parliamentary grant.

I have the honour to be  
Your obedient servant,  
JAMES NORRIS,  
President of C. C. C.

J. Norman Lockyer, Esq.,  
Secretary, &c.

13. *Christ Church.*

A STATEMENT of the Means provided at Christ Church, Oxford, for the Advancement of Science and for Scientific Instruction.

1. The main sources from which the endowments devoted to natural science at Christ Church are derived, are the estates bequeathed in trust to the Dean and Chapter by Matthew Lee, M.D., by his will, bearing date August 27th, 1755. A copy of the provisions of the will, so far as they relate to this part of the subject, will be found printed in the report of the Royal Commission appointed to inquire into the state, &c., of the University of Oxford (1852), at p. 282 of the Evidence.

2. The provisions of the will are various. The rental of the estates has increased to a considerable sum, and the net income may be taken at about 2,650*l.* a year. Several decrees in Chancery have been obtained by the Dean and Chapter for extending the powers granted to them under Dr. Lee's will. Considerable modifications of these powers were also introduced by the ordinance or statutes framed by the University Commission in 1858, and by subsequent alterations in that ordinance made by the governing body of Christ Church in virtue of powers conferred by the ordinance itself, no alteration being valid till it has received the sanction of Her Majesty in Council.

3. It may be as well to explain here that the government of Christ Church and the administration of its funds, trust as well as corporate, were transferred from the Dean and Chapter by an Act passed in 1867 to a new governing body, consisting of the Dean, the Canons, and the Senior Students of Christ Church. The Senior Students are equivalent to



the fellows in other colleges, and the junior students, it may be added, are equivalent to the scholars in other colleges.

4. Of the augmented revenues of Dr. Lee's estates, the sum of 1,260*l.* a year is at present devoted by the ordinance above named to the payment of junior students elected from Westminster School. It rests with the governing body to determine what portion of the remaining revenues is to be applied to the purposes of advancing science and providing scientific instruction for the young men. What has been already done in this direction shall here be stated.

5. By Dr. Lee's will a lecturer in anatomy was to be maintained, with a salary of 100*l.* a year, and an allowance of 40*l.* for providing human subjects and anatomical preparations for the purpose of his lectures. This lecturer was to hold the position of a University Teacher; he was to admit all applicants to his lectures, and was authorised to take fees from all who attended each course, with the exception of a fixed number of Christ Church undergraduates, who were to be taught without fee or reward.

6. Dr. Acland was appointed to the office in 1845, under the provisions of the will, except that the Reader's salary had before his appointment been raised to 200*l.* He applied himself with great zeal and energy to bringing the department abreast with the requirements of modern science, and gave lectures, which were well attended. In particular, he obtained from the Dean and Chapter grants of money, averaging about 500*l.* a year, to assist him in retaining the services of an assistant, and in making preparations for the use of students. But he expended much, not only of his time, but of his own money in the same work, and succeeded in forming an excellent series of preparations, chiefly osteological and physiological, arranged and catalogued after the Catalogue of the Hunterian Museum. His own account of the collection as it was in 1852 will be found in the evidence he gave to the first University Commission. (Evidence, p. 283.)

7. Dr. Rolleston succeeded Dr. Acland in 1858, and zealously carried on the work of his predecessor, both in lecturing and in enlarging the collections. He resigned the Readership in 1860, when he was elected to the Linacre Professorship of Physiology, then newly created and endowed by Merton College in pursuance of an ordinance made by the second University Commission.

8. Meantime, the Lee's Readership in Anatomy had been, by an order of the same Commission, constituted as a Senior Studentship of Christ Church, and with it a second readership (in chemistry) was founded, both being endowed out of the Lee's fund. These two Readers take rank with the other members of the governing body, according to seniority.

9. The new Linacre Professor was attached to the University Museum, which had been recently erected and endowed out of the University chest at a very large expense. About the time of Dr. Rolleston's appointment, the Dean and Chapter (who then still retained the government of Christ Church) had to consider whether they would continue to keep up the anatomical and physiological collections. It was plain that the Linacre Professor must have collections for his own use in the new museum; and the question was whether it was worth while, in one small town, to have two collections of this kind, one in the museum and one at Christ Church, when it appeared certain that one collection would be all that would be required for purposes of study and instruction. The Dean and Chapter considered that, by retaining their collections, they would be obliging the University to incur a large outlay, and would be compelled themselves to spend a considerable sum annually in keeping up their own collections, which sum might be more usefully employed in promoting other scientific studies. They determined, therefore, to transfer their collections, as a loan to be reclaimed at any time that might be thought expedient, to the University museum. The Lee's Reader in Anatomy has a room assigned him at that museum; he retains the right of making full use of the Lee's collections, and he is also enabled to lecture in the physiological lecture room of the museum, by arrangement with the Linacre Professor; so that while Christ Church men receive his instruction, as before, he strengthens the teaching staff at the museum in no inconsiderable degree.

10. Dr. Acland resigned the Lee's Readership on being appointed Regius Professor of Medicine in the University. The University had in the department of medicine no collections whatever. The Dean and Chapter, acting as they had done in respect of the physiological collection, presented to Dr. Acland, as the foundation of a pathological collection in the museum, those specimens of morbid anatomy which he had deposited in the Christ Church building. They considered this due to the professor, in acknowledgment of the expenditure, both of time, labour, and money, which he had made in their service. These pathological specimens might

in fact have been regarded as his own property, though he had left them at Christ Church. He has now presented them to the University.

11. In 1866, the Christ Church building, being thus left vacant by the transfer of the several collections above-named to the University museum, was fitted up as a chemical laboratory and lecture room, by payments out of the balance on the Lee's fund to the amount of more than 500*l.* The expense of maintaining the laboratory, chiefly for the use of young men, amounts to about 100*l.* a year; and a grant of 60*l.* a year is made to the Reader in Chemistry to enable him to secure the services of an assistant.

12. In 1869, a third Readership was created by the governing body, under powers conferred by a new statute, framed by them, and confirmed by Her Majesty in Council. This Reader is to study and teach mathematical and experimental physics. A grant of 100*l.* has recently been made for the purchase of physical apparatus of an elementary kind. For the present, this Reader shares the lecture room of the chemical reader. More advanced instruction in physics will have to be sought in the Hyde Institute, just erected as an adjunct to the University museum.

13. One of the rooms in Dr. Lee's building at Christ Church has been fitted up as a library and reading room for the use of the Lee's Readers and of undergraduates engaged in the study of physical science. The sum of 100*l.* has been granted for the purchase of standard works; and it is intended to provide scientific periodicals and other additions to the library as they may be needed.

14. By successive alterations of the Lee's trust, made partly under the authority of the Court of Chancery, partly by the University Commissioners, and partly by the governing body under the sanction of Her Majesty in Council, the present state of the Lee's trust fund, so far as it is annually expended upon scientific objects, is this:

	£	s.	d.
Three Readers (in anatomy, chemistry, and physics) receive each 300 <i>l.</i>	-	900	0 0
Chemical laboratory expenses (about)	-	100	0 0
Chemical assistant	-	60	0 0
Mathematical teachers	-	250	0 0
Other expenses (about)	-	50	0 0
		<u>£1,360</u>	<u>0 0</u>

15. The Lee's Readers also receive 250*l.* from the fees paid by the undergraduates for tuition, and the mathematical Tutors receive 450*l.*, so that the whole salary

	£
of the Chemical Reader is	- 450
" Anatomical Reader	- 350
" Physical Reader	- 350
" Mathematical Teachers	- 700
Total expended in salaries to teachers	<u>- £1,850</u>

16. It appears, therefore, that during the last 25 years, a large and increasing sum has been set apart by Christ Church, out of funds at the command of the corporate body, for encouraging scientific study and providing scientific instruction for young men.

17. It should be added, that by alterations of the ordinance, made in 1868 and 1869, with the sanction of Her Majesty in Council, the Lee's Readers are, with the consent of the Dean and two-thirds of the governing body, permitted to marry, and to hold property beyond the amount to which other Senior Students are restricted. Their income also is allowed, with the same consent, to be raised to any sum exceeding 200*l.* a year; this sum of 200*l.* being taken as the minimum.

18. What has been said relates chiefly to the Lee's Readers, and the department connected with the higher studies and teaching. It must be added, that, by the ordinance of the Commissioners, made in 1858, it was provided that "in elections to one in every three open junior studentships, the subjects of competitive examination shall be alternately mathematics and physical science." These junior students receive 75*l.* in money, exclusively of rooms rent free, so that the value of a junior studentship may be taken at nearly 90*l.* a year. These studentships are tenable for five years from the day of election. On the 1st of January 1870, out of 30 open junior studentships, there were five mathematical, and five in physical science. But it should be remarked that the governing body, acting as electors, are not restricted to the minimum fixed by the Commissioners of one in every three for mathematics and physical science alternately. Hitherto the number of competitors for each physical science studentship has been very small; but, doubtless, as the teaching of these subjects increases and is improved in schools, so the number of com-



petitors will increase also; and the electors will (I feel sure) promptly consider it their duty to augment the number of studentships appropriated to scientific studies.

(Signed) H. G. LIDDELL,  
Dean of Christ Church, Oxford.

July 19, 1870.

#### 14. *Trinity College.*

Trinity College, Oxford,  
August 5th, 1870.

SIR,  
IN answer to your circular of the 13th June, I beg to state that no sums derived from endowments or from parliamentary grants are applied to the advancement of science or to scientific instruction in this College.

The tuition fund of this College is to some extent employed in providing scientific instruction for members of the College, but this does not proceed from endowments. No parliamentary grants of any kind are received by the College.

In answer to the circular of the 4th inst., I beg to state that, considering the circumstances of Trinity College, I have no facts or suggestions to lay before the Aid to Science Commission.

I have the honour to be, Sir,

Your obedient servant,

S. W. WAYTE,  
President of Trinity College.

J. Norman Lockyer, Esq., Secretary,  
Aid to Science Commission.

#### 15. *St. John's College.*

[No answer received.]

#### 16. *Jesus College.*

[No answer received.]

#### 17. *Wadham College.*

Wadham College, Oxford,  
June 17th, 1870.

SIR,

I HAVE the honour, in answer to your letter of the 13th inst., to inform the Royal Commissioners on Scientific Instruction that Wadham College has received no aid by parliamentary grant for scientific instruction or advancement of science, but that it has received some endowments, as follow:—

1. An exhibition of 10*l.* yearly for the study of botany.  
2. Do. of 90*l.* yearly to a Fellow of the College for the study and practice of medicine.

3. Do. of 18*l.* yearly to a Scholar of the College for the study of chemistry, anatomy, and medicine (if no fellow or scholar competent, to be otherwise appropriated).

The College pays out of its own funds 200*l.* annually towards the salary of a Professor of Experimental Philosophy in the University of Oxford. Further instruction is given within the College, or provided therein, for its own students in chemistry, physiology, and physics.

I am, Sir,

Your faithful servant,

B. P. SYMONS,

Warden of Wadham College.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### 18. *Pembroke College.*

Pembroke College, Oxford,  
June 23rd, 1870.

SIR,

IN reply to your inquiry as to "what sums are applied to the advancement of science, or to scientific instruction in this College, which are derived from endowments or parliamentary grants," I beg to inform you that the only endowment in this College which comes within the above designation is a medical fellowship founded by the late Mrs. Sheppard, in the examination for which, on the last occasion, natural science (viz., chemistry and physiology) was included, and formed a very important part; and in all probability the same rule will be observed on all future occasions. The value of the fellowship is 200*l.* a year.

I have the honour to be

Yours faithfully,

E. EVANS,

Master of Pembroke College.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### 19. *Worcester College.*

Worcester College,  
June 16th, 1870.

SIR,

I HAVE the honour to inform you that Worcester College has no surplus funds to apply for the advancement of science. Our fellowships are under 200*l.* per annum, almost, if not quite, the lowest in the University, and the tutors are paid solely by the fees of the undergraduates.

I have the honour to be, Sir,

Your obedient servant,

R. L. COTTON,

Provost of Worcester College.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### HALLS.

##### 1. *St. Mary Hall.*

St. Mary Hall, Oxford,  
June 20th, 1870.

DEAR MR. VICE-CHANCELLOR,

My answer, unfortunately, is very short.

1. This Hall has no endowment or parliamentary grant for the advancement of science or for scientific instruction.

2. I am not able to make suggestions, or to give evidence to Her Majesty's Commissioners on this matter.

I am, dear Mr. Vice-Chancellor,

Yours very faithfully,

D. P. CHASE, Principal.

The Rev. the Vice-Chancellor.

##### 2. *Magdalen Hall.*

Magdalen College, Oxford,

June 29th, 1870.

SIR,

I HAVE the honour to assure you that Magdalen Hall enjoys no endowment or parliamentary grant whatever for the cultivation or aid of scientific instruction of any sort.

Your obedient servant,

R. MICHELL, D.D.,

Principal of Magdalen Hall.

J. N. Lockyer, Esq.

(Endorsed)

F. K. LEIGHTON,

Vice-Chancellor,

All Souls' College,

July 2nd, 1870.

##### 3. *New Inn Hall.*

New Inn Hall,

June 23rd, 1870.

DEAR MR. VICE-CHANCELLOR,

IN reply to the inquiries made through you by the Secretary to the Royal Commission of Scientific Instruction and the Advancement of Science, I beg to state that New Inn Hall neither derives any aid from parliamentary grant, nor enjoys any endowment for the advancement of science or scientific instruction. I beg to remain

Very faithfully yours,

H. H. CORNISH, Principal.

The Rev. the Vice-Chancellor of Oxford,

All Souls'.

(Endorsed)

F. K. LEIGHTON,

Vice-Chancellor.

##### 4. *St. Alban Hall.*

St. Alban Hall,

June 20th, 1870.

MY DEAR MR. VICE-CHANCELLOR,

THE statement which I have to make to the Royal Commissioners is a very simple one.

St. Alban Hall derives nothing from endowment or parliamentary grant, or any other external source whatever.

I am, dear Mr. Vice-Chancellor,

Very truly yours,

W. C. SALTER,

Principal.

The Rev. the Vice-Chancellor.

(Endorsed)

F. K. LEIGHTON,

Vice-Chancellor.



### 5. St. Edmund Hall.

There are no such endowments or grants at St. Edmund Hall.

(Signed) EDW. MOORE, B.D.,  
Principal.

(Endorsed) F. K. LEIGHTON,  
Vice-Chancellor.

## UNIVERSITY OF CAMBRIDGE.

Clare College Lodge, Cambridge,

July 7th, 1870.

SIR,

IN reply to the letter of the 13th of June last, addressed to me as Vice-Chancellor of this University, I have the honour to send, for the information of the Royal Commission on Scientific Instruction and the Advancement of Science, the following statement:—

No sums whatever, which are applied to the advancement of science and scientific instruction in the University of Cambridge, are derived in the proper sense of the words from parliamentary grants. Before the year 1858, when the stamp duties formerly payable on matriculation and degrees in the University of Cambridge were repealed, the following salaries and allowances to scientific professors were annually voted by Parliament:—

	£
To the Professor of Chemistry -	100
To the Professor of Anatomy -	100
To the Professor of Botany -	182
To the Jacksonian Professor -	100
To the Professor of Mineralogy -	100

The Act for the repeal of the stamp duties provides that none of the above salaries or allowances, which the University had previously undertaken by grace to pay annually out of its common chest, shall be discontinued or reduced without the consent of the Commissioners of Her Majesty's Treasury.

The salaries of all the above professors are now made up to 300*l.* per annum out of the University chest, none having any independent endowment except the Jacksonian Professor, who receives 160*l.* per annum from the endowment of his professorship, and 140*l.* only from the University chest.

The other professorships which have to do with some branch or other of science are the following, which I give in the order of their establishment:—

1. The Regius Professorship of Physic founded in 1540, the original endowment of which, 40*l.* per annum, has been reduced by government fees to 34*l.* To this is now added the annual rent of a house left to the professor in 1651 by Mr. Crane, which amounts to 150*l.* per annum.

2. The Lucasian Professorship of Mathematics, founded 1663, is endowed with an estate of which the value now is about 150*l.* per annum. This endowment has been recently augmented by the assignment of three-eighths of the net income of the Sadlerian Trust, which three-eighths amount to about 415*l.* per annum.

3. The Plumian Professorship of Astronomy and Experimental Philosophy, founded in 1704, was endowed with an estate, now of the value of about 260*l.* per annum. This was increased by a bequest of about 46*l.* per annum from Dr. Robert Smith in 1768, and has been recently further increased by the assignment of one-eighth part (amounting to about 138*l.* per annum) of the net income of the Sadlerian Trust.

4. The Woodwardian Professorship of Geology, founded about 1730. The net annual value of the estate with which it is endowed is about 400*l.*, but the income is charged with other expenses, all of which, however, have reference to the science of geology. The University makes the Professor's income 500*l.* per annum, supplying whatever may be necessary for that purpose from the University chest.

5. The Lowndean Professorship of Astronomy and Geometry, founded in 1749, is endowed with an estate producing about 400*l.* per annum. The present Professor acts also as Director of the Observatory, for which he receives a further stipend of 250*l.* per annum from the University chest.

6. The Jacksonian Professorship, founded in 1783, seems to have been intended by the founder principally as a Professorship of Natural Philosophy. The present Professor lectures on mechanism, statics, and dynamics, with their practical application to manufactures and the steam-engine. An account has already been given of the income of the professorship.

7. The Sadlerian Professorship of pure Mathematics,

established in 1863, is endowed with a sum of about 550*l.* per annum, being one-half of the net income of the Sadlerian Trust Estate. The remaining half is applied, as has been already mentioned, to the augmentation of the Lucasian and Plumian Professorships.

8. The Professorship of Zoology and Comparative Anatomy, established in 1866, is endowed with an annual payment of 300*l.* from the University chest.

The University has also established a Demonstrator of Anatomy and a Superintendent of the Museums of Zoology and Comparative Anatomy, each of whom receives 100*l.* per annum from the University chest.

A sum of about 400*l.* per annum is paid from the University chest to examiners in various departments of science.

The only prizes that have been founded in the University for the encouragement of science are—

1. Dr. Smith's two prizes to two commencing Bachelors of Arts in each year, the best proficient in mathematics and natural philosophy. The endowment of these consists of half the interest of a sum of 3,850*l.* new 2½ per cents., the other half being appropriated to the augmentation of the Plumian professorship.

2. The Adams prize, given once every two years to the author of the best essay on some subject of pure mathematics, astronomy, or some other branch of natural philosophy. The endowment consists of the sum of 2,147*l.* 13*s.* 7*d.* 3 per cent. consols.

3. The Sedgwick prize, given every third year for the best essay on some subject in geology or the kindred sciences. The endowment consists of the sum of 500*l.* Scinde railway stock.

A sum of 10,000*l.* 3 per cent. consols was transferred in the year 1859 by the representatives of the late Rev. Richard Sheepshanks to the Master, Fellows, and Scholars of Trinity College, in trust, that one-sixth part of the annual proceeds should be applied every year for the maintenance of an exhibition to be called "the Sheepshanks Astronomical Exhibition," the exhibitor to be elected by the Masters and Seniors of Trinity College from the whole University after an examination; the remaining five-sixths for the promotion of the science of astronomy in the University of Cambridge, and for rendering efficient the Cambridge Observatory for the benefit of astronomy, or of terrestrial magnetism or meteorology, or of such other sciences as are or may be continuously followed in an Observatory. The unexpended balance each year is required to be invested and added to the principal, and the proceeds applied in like manner with the proceeds of the original five-sixths.

In addition to the grants from the Sheepshanks fund, the University has expended annually, on the average of the last seven years, the sum of 710*l.* 1*s.* 3*d.* from the University chest on the maintenance of the Observatory, including the above-named stipend of 250*l.* to the Director of the Observatory.

The following endowments have been left for the maintenance of the Botanic Garden:—

1. Rentcharge of 50*l.* per annum by Dr. Walker, formerly Fellow of Trinity College.

2. A sum of 2,000*l.* 3 per cent. reduced annuities, by Lord Maynard.

3. A sum of 2,000*l.* 3 per cent. reduced annuities, by Rev. E. Betham.

In addition to the annual proceeds of these endowments, the University has expended upon the maintenance of the Botanic Garden, on the average of the last seven years, an annual sum of 548*l.* 11*s.* 1*d.* from the University chest.

A sum of 1,500*l.* is appropriated each year from the University chest for the maintenance of the chemical school, and of the various museums of mineralogy, geology, botany, zoology, comparative anatomy, and human anatomy. A further sum of 1,000*l.* is also at present appropriated annually from the chest for the furniture and fittings of the new museums, and the liquidation of the debt on the buildings.

It will appear from the above statement that the annual amount arising from endowments, properly so called, which is applicable to the promotion and encouragement of science in the University of Cambridge is about 3,300*l.* per annum.

The annual amount which is applied to the same purposes from the University chest, for the payment of which the University has rendered itself responsible, is about 6,100*l.*

It may be proper to explain that the income of the University chest arises principally from the capitation tax levied quarterly upon all persons whose names are on the boards of the University, and from the matriculation, previous examination, and degree fees. The net income of the chest from funded and real property cannot be estimated at more than 1,500*l.* per annum.



I shall have great pleasure in giving more detailed information, to the best of my ability, on any matters which may seem to the Commissioners to require it.

I have the honour to be, Sir,

Your very obedient servant,

E. ATKINSON,

Vice-Chancellor of the University of Cambridge.

J. Norman Lockyer, Esq.,

Secretary to the Royal Commission on Scientific Instruction.

#### COLLEGES.

##### 1. *St. Peter's College.*

St. Peter's College, Cambridge,

July 9th, 1870.

SIR,

In reply to your letter of the 11th of June, I have the honour to inform you, for the Royal Commissioners on Scientific Instruction and the Advancement of Science, that no sums are received by St. Peter's College for the advancement of science or for scientific instruction from parliamentary grants.

I have the honour to give you the following further information:—

At St. Peter's College there are 14 foundation fellowships. In the case of a vacancy, any one who had distinguished himself in the University examinations for honours in mathematics (including natural philosophy), or in the natural sciences tripos, would have the same claim to be elected as a candidate who had distinguished himself in the classical or moral sciences, or law and history tripos.

It must not be understood that a candidate, who had been first in the natural sciences tripos, would, as a matter of course, rank equally with a senior wrangler or a senior classic; it is only meant that no distinction would be made between the candidates merely on account of the subjects which they had severally selected for their examinations.

There are 21 scholarships, varying in value from 20*l.* to 80*l.* per annum each, and amounting altogether to 1,000*l.* per annum. About one-half of these have been adjudged to candidates who have distinguished themselves in mathematics, and about one-half to those who have distinguished themselves in classics. On two occasions the College has opened a scholarship for public competition in natural science, but the number of candidates in both cases was extremely small. One scholarship only has been so awarded.

I shall be happy to give any further information in my power to the Royal Commissioners.

I am, Sir,

Your obedient servant,

H. W. COOKSON,

Master of St. Peter's College.

J. Norman Lockyer, Esq.,

Royal Commission on Scientific Instruction and the Advancement of Science.

##### 2. *Clare College.*

Clare College Lodge, Cambridge,

July 7th, 1870.

SIR,

In reply to the printed circular, dated June 11, 1870, which you have addressed to me as Master of Clare College, on behalf of the Royal Commission on Scientific Instruction and the Advancement of Science, I have to state as follows:

No sums of which this College has the disposal are derived from parliamentary grants.

There are no endowments under the control of this College which have been specially designed to aid scientific instruction or the advancement of science. The Master and Fellows are directed to elect no one into a scholarship "nisi qui moribus doctrina et scientia secundum examina quae hanc in rem instituta fuerint, magistro et sociis sese approbaverit." Mathematics, pure and mixed, always form a principal subject of examination, and, in point of fact, the majority of our scholarships is awarded to those who excel in mathematics, but, in point of fact, it might happen at any examination that all or nearly all the scholarships were given for excellence in other subjects. I am unable, therefore, in respect of the scholarships generally, to specify any particular sum as applied by the College towards scientific instruction or the advancement of science. In each of the last two years, however, the College has offered, and intends for the future to offer every year, a scholarship of 50*l.* per annum tenable for 3½ years for natural science (that is to say, chemistry, light, heat, and

electricity, comparative anatomy, and physiology and geology). In the former of these years no candidate sufficiently deserving offered himself. But in the present year one of the candidates was elected. At the present time, therefore, only 50*l.* per annum is applied expressly towards the encouragement of natural science in the way of scholarships. Should satisfactory candidates offer themselves in future years, the sum which will be annually given for the encouragement of natural science will be 175*l.* three years hence.

The College contributes 10*l.* per term from its corporate funds to each of the two college lecturers who lecture every term in mathematics and natural philosophy, in addition to the share which they receive of the undergraduates' tuition money.

In the election of fellows the Master and Fellows are required by the statutes always to prefer those "qui moribus et conditione fuerint insigniores quosque magister et socii speraverint firmiterque crediderint ad *Die honorem* et profectum bonarum litterarum et scientiae cum effectu velle et posse proficere." The Master and Fellows have regard in the election to distinction obtained in any college or University examination of whatever kind. A considerable majority of the present fellows was elected in consideration of their places in the mathematical tripos. Still I cannot regard the income which they receive as Fellows from the corporate funds of the College in the light of money expressly "applied to the advancement of science or to scientific instruction," although these objects are indirectly greatly promoted by such expenditure.

I am obliged, therefore, to state that, according to the best of my judgment, a sum of 50*l.* per annum paid to a natural science scholar, and a sum of 60*l.* per annum paid to two lecturers in mathematics and natural philosophy, are the only sums directly applied to the advancement of science and to scientific instruction, which are derived from the endowments of this College.

I have the honour to be, Sir,

Your very obedient servant,

E. ATKINSON,

Master of Clare College, Cambridge.

J. Norman Lockyer, Esq., F.R.S.,

Secretary to the Royal Commission on Scientific Instruction.

##### 3. *Pembroke College.*

Pembroke College, Cambridge,

June 15, 1870.

SIR,

I BEG to acknowledge the receipt of your letter of the 11th inst., and to return the following reply to the enquiries of the Commissioners.

This College is not in the possession of any funds derived from parliamentary grants.

I imagine that, by the term "science," the Commissioners understand the various branches of natural science only, and that their enquiries do not refer to mathematics. In the above sense of the word, we have no endowments applied exclusively to the advancement of science or to scientific instruction. The scholarships of the College, however, amount to about 1,000*l.* a year, and the Master and Fellows are quite prepared to apply a portion of these to the encouragement of science, if sufficiently qualified candidates present themselves. Hitherto this has not been the case, and the scholarships have all been awarded for classics and mathematics only. An attempt is now being made by the University to establish a Professorship of Experimental Physics, and to provide buildings and apparatus for that department of science, and I trust that by these and similar means the number of students is likely in future to be largely increased, and that we may be able to elect such students, not only to the scholarships, but also to the fellowships of the College. I may add that by an arrangement with several of the adjacent colleges, provision has been made for the delivery of intercollegiate lectures, on scientific subjects, to the students of this and the other allied colleges.

I have the honour to be, Sir,

Your obedient servant,

J. POWER,

Master of Pembroke College.

J. Norman Lockyer, Esq.,

Secretary, &c.

##### 4. *Gonville and Caius College.*

Sandford Park, Oxon.

June 30th, 1870.

SIR,

In answer to the inquiry contained in your circular of the 11th inst., I have to state that the aid which is



afforded to science by Gonville and Caius College consists, 1st, in its fellowships; and 2ndly, in its scholarships, prizes, &c. The value of the fellowships and scholarships varies with the net income of each year. Last year there was expended:

	£	s.	d.
For 38 scholarship	1,632	0	0
For prizes	60	0	0
For Schuldam plate	10	0	0
For Thruston speech	18	0	0

The Thruston speech is an annual review of the latest advances made in medical science; the Schuldam plate is given to the most deserving among the commencing Bachelors of Arts; and the prizes go to those who have best acquitted themselves at the College examinations. A scholarship is given away every year for proficiency in chemistry, and another for proficiency in the study of anatomy. As these scholarships are held on an average for three years, it follows that 6 of the 38 scholarships are devoted to the encouragement of anatomy and chemistry. The remaining 32 scholarships are given, but not in any definite proportions, as rewards for success in other lines of study—mathematics, classics, the moral sciences, &c.

The most effectual way in which a college may encourage particular studies lies in the election to its fellowships. Fellowships may be confined to the scholars of a college, which is the prevalent custom at Cambridge, or open (as at Oxford) to the whole University. Our own College, as a general rule, follows the Cambridge custom, but instead of examining the candidates, takes for its guide the University degree. By this mode of procedure, it raises its elections above all suspicion of favouritism or jobbery, while its knowledge of the candidates is a guarantee that no man whose moral conduct is open to suspicion will be allowed to intrude himself into the society. A difficulty, however, arises when we have candidates before us who have earned distinction in *different* lines of study. In such cases, we have no common unit whereby we can measure the claims of the candidates, and much trouble has arisen in consequence. It has been suggested that particular fellowships might be considered as appropriated to men who had earned particular distinctions—literary, scientific, or otherwise. If this were looked upon, not as a rigid rule, which might compel us occasionally to admit inferior men, but as a general understanding among the Fellows of the College, we might, I think, in part at least, get over the difficulties, and be able to extend more widely the benefit of these endowments.

Owing to its confined site, and the situation of our College in the very heart of Cambridge, we have had great difficulty in providing suitable accommodation for the study of certain branches of science. We cannot have a proper laboratory, for instance, within the College or in its immediate neighbourhood without danger of creating a nuisance. We have been very anxious to supply the want, but all our efforts in this direction have hitherto been in vain, and our only means at present of studying chemistry, practically, are such as are provided by the University. A proposition was made a short time since to increase the funds of the University applicable to scientific purposes, and our College expressed its willingness to aid this object by its contributions, provided it had some voice in the application and management of the sums contributed. It refused to hand over any portion of its corporate funds unconditionally to another corporation, 1st, because the demand was thought unreasonable, and 2ndly, because little confidence was placed in the judgment ordinarily exercised by the University in the management of the funds placed under its control.

In conclusion, I may be allowed to express my belief that there is, both in our own College and in the University generally, a sincere wish to encourage, as far as they consistently may, that practical study of physics which I apprehend it is the object of the Commission to promote. Where there are so many conflicting interests to reconcile, it is obvious that prudence is necessary in the endeavour to effect this purpose. Precipitate action might do more harm than good. It would be, indeed, a sad thing if, in becoming "Physicists," we were to put into jeopardy the character of our University, as the great mathematical school of Europe.

I have the honour to be, Sir,  
Your obedient servant,  
EDWIN GUEST.

J. Norman Lockyer, Esq.

### 5. Trinity Hall.

Trinity Hall, Cambridge,

June 15th, 1870.

SIR,

IN reply to your letter of the 11th instant, as it is difficult to determine precisely what portion of the allowance out of the College funds for general instruction of the students can be considered as specially applied for what is termed "scientific instruction" or for the "advancement of science," I think it better to state that at Trinity Hall instruction is given to the students in classics, law, divinity, the English language, and literature, and also in mathematics and natural philosophy.

That, by an arrangement between Trinity Hall and King's College, lectures are given to their respective students, in optics, hydrostatics, and astronomy, and the apparatus to illustrate such lectures is provided by the two colleges. By a like arrangement with some other colleges, students of Trinity Hall are admitted to their lectures in natural and applied science, and in return their students are admitted to lectures at this College in law, the English language, and literature.

By the statutes of Trinity Hall, three fellowships are attached to tutorial offices, their aggregate stipends about 1000*l.*, and the stipend of 120*l.* paid by the College to the law lecturer, constitute the amount paid out of the College funds for the instruction of the students; about one half of the former sum may be considered as applied for "scientific instruction" or for the "advancement of science."

Three other lecturers are employed to assist the College Tutors, who are paid out of the tuition fees payable by undergraduates; the law lecturer receives a portion of these fees in addition to his stipend. A sum of between 500*l.* and 600*l.*, arising from the general college endowments, is disposed of annually on prizes and scholarships for the undergraduates; about one half of this sum is usually given for proficiency in mathematics and natural philosophy.

In December last, a proposal was made, based on the report of a Syndicate, to raise, by contributions from the colleges, the necessary funds for more extended professional instruction on various subjects of science.

This College expressed its willingness to contribute according to one of the plans, namely, an annual sum equal to 3*l.* per cent. on its distributive income, that is, on the aggregate amount of the income paid out of the College to the Master, Fellows, Scholars, and some other college officers, provided the other colleges were willing to make a similar contribution, but from a want of unanimity of the colleges on the subject, the above proposal has not yet been adopted.

I am, Sir,

Your obedient servant,  
T. C. GELDART,  
Master of Trinity Hall.

J. Norman Lockyer, Esq.,  
Secretary, &c.

### 6. Corpus Christi College.

[See p. 23.]

### 7. King's College.

King's College, Cambridge,

August 9th, 1870.

SIR,

IN answer to your former letter of June 11th last, I had procured from my College the accompanying return, but I abstained from sending it, after hearing from Professor Stokes, in conversation, that it was not the sort of information intended by the Commissioners.

Your second letter of the 6th instant, asking for a return of the number of students attending classes in which science is taught, seems as little to require any information which can be given from King's. But I am unwilling, after a second appeal, to remain entirely silent, and, therefore, enclose the return which I had procured under a first interpretation of the terms "Scientific Instruction and the Advancement of Science."

I have the honour to be, Sir,

Your obedient servant,  
RICHARD OKES, Provost.

J. Norman Lockyer, Esq.,  
Secretary, &c.

MATHEMATICAL INSTRUCTION AT KING'S COLLEGE,  
CAMBRIDGE.

There are two mathematical lecturers at salaries of 150*l.* and 80*l.* per annum respectively.

Prizes to the amount of 10*l.* are annually given for instruction in mathematics.



Mr. Richards, a former fellow of the College, bequeathed to the College a legacy of 20*l.* annually for the scholar who shall have passed the best mathematical examination in his third year.

Mr. Martin Thackeray, formerly fellow of the College, left 1,000*l.*, the interest of which is to be given to the scholar of King's College (educated at Eton) who shall take the highest degree among the wranglers in the mathematical tripos.

RICHARD OKES, Provost.

August 9th, 1870.

#### 8. *Queen's College.*

Queen's Lodge, Cambridge,

June 14th, 1870.

SIR,

I HAVE the honour to acknowledge the receipt of your communication of the 11th.

At an examination for minor scholarships held in the beginning of last month, three scholarships were given for mathematics, and one for classics. Generally more scholarships are given for mathematics than for classics. Not only are the greater number of scholarships in this College obtained by mathematics, but most of the fellowships have also been given for proficiency in them.

We have here a studentship of 50*l.* a year, which is now held for proficiency in the natural sciences.

As for scientific instruction, there are college lectures, and intercollegiate lectures in all the branches of science which are pursued in the University.

I shall be happy to furnish you with any further information you may desire.

I have the honour to be, Sir,

Your obedient servant,

J. Norman Lockyer, Esq.,  
Secretary, &c.

GEO. PHILLIPS.

#### 9. *St. Catharine's College.*

The Close, Norwich,

17 June 1870.

SIR,

I HAVE the honour to acknowledge the receipt of your letter of inquiry, dated June 11, 1870.

I beg to inform you that my College enjoys no parliamentary grants either for the advancement of science or for scientific instruction.

There are no endowments in my College for either purposes; but certain fellows of the College, who are appointed to the offices of tutor or of lecturer, are in the habit of instructing the college students in mathematics during each academical term.

As the Commissioners are pleased to invite suggestions, I beg to offer this for their consideration:—That colleges should be empowered to confer fellowships upon scientific professors in their own University. The usual restrictions in reference to celibacy and the amount of private or public income enjoyed by the fellows being, in this special case, abrogated.

I believe that our colleges would avail themselves of this opportunity of thus supplementing the income of professors, and of adding distinguished men to their own governing body.

I am, Sir, your obedient servant,

CHARLES KIRKBY ROBINSON,

Master of St. Catharine's College, Cambridge.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### 10. *Jesus College.*

[See p. 24.]

#### 11. *Christ's College.*

Christ's College, Cambridge,

9 February 1871.

SIR,

I VERY greatly regret that I have not long ago answered the inquiry which you addressed to me in regard to the aid and encouragement given in this College to students prosecuting natural and applied science.

There is at present no direct instruction given in the College itself on subjects of this nature.

But, in the spring of 1870, we held an examination for open scholarships of students about to commence residence at the University, the subjects being those of the Natural Science Tripos, which comprise Chemistry, Botany, Geology, Mineralogy, and Zoology, with Comparative Anatomy and Comparative Physiology; and we gave two scholar-

ships of 70*l.* and 50*l.* a year, respectively, for proficiency in some or other of these subjects.

We purpose making this an annual examination.

We shall also, for the future, examine those of our resident students, who are pursuing natural science, in each year of their undergraduate course, and reward those who are distinguished with prizes and scholarships, or increased scholarships, as the case may be.

The Fellows of the College and myself are fully aware of the importance of aiding the pursuit of natural and applied science by our students; and I do not conceive that we are under any legislative disability in regard to the appropriation of our funds to this purpose.

I have the honour to be, Sir,

Your faithful servant,

JAMES CARTMELL,

Master of Christ's College.

J. Norman Lockyer, Esq.

#### 12. *St. John's College.*

St. John's College, Cambridge,

June 25th, 1870.

SIR,

In reply to the circular letter addressed to me by the Royal Commissioners on Scientific Instruction and the Advancement of Science, dated 11th June 1870, I have the honour to state—

1. That St. John's College receives no parliamentary grant of any description.

2. That no endowment of the College is in terms specifically appropriated to scientific instruction.

3. That under the discretionary powers vested in the governing body of the College, several appropriations of money have been at different times made for the purposes referred to by the Commissioners, viz.:

500*l.* to 600*l.* for the building of a chemical laboratory.

150*l.* per annum for the stipend of a Superintendent thereof, who also gives lectures on chemistry to members of the College, as well as to other students.

100*l.* per annum for the stipend of a lecturer on geology.

150*l.* per annum for the maintenance of three exhibitions for natural science, of the yearly value of 50*l.* each, which exhibitions are more particularly described in the printed paper enclosed herewith. [See below.]

4. That the general staff of College lecturers include within their course of instruction much that is embraced within the term science, which it is probably unnecessary for me to describe more particularly in this statement.

5. That it is the practice of the College to elect to foundation fellowships and scholarships students who are eminent for their scientific attainments, with the same degree of favour as students who are distinguished in the other studies recognised by the University.

To the foregoing statement, I beg leave to add that it will give me pleasure to answer any further inquiries which H. M. Commissioners may address to me; and

I have the honour to be, Sir,

Your obedient servant,

W. H. BATESON,

Master of St. John's College, Cambridge.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### SAINT JOHN'S COLLEGE, CAMBRIDGE.

##### *Minor Scholarships and Open Exhibitions for the Year 1870.*

In the year 1870 there will be open for competition four minor scholarships, two of the value of 70*l.* per annum, and two of 50*l.* per annum, together with

Three exhibitions of 50*l.* per annum, tenable on the same terms as the minor scholarships.

The examination of candidates for the above-mentioned scholarships and exhibitions will commence on Tuesday, the 26th of April 1870, at 9 a.m.

The examination will consist of three mathematical papers, and four classical papers; and the latter will contain passages of Greek and Latin prose and verse for translation into English, and also each a passage from an English author for the corresponding prose or verse composition.

In addition to the papers above mentioned, the candidates will be examined *vivâ voce* in classics; and the Masters and Seniors wish it to be understood that a candidate may be elected on the ground of proficiency in either the classical or the mathematical branch of the examination, independently of the other.

Besides the seven minor scholarships or exhibitions above mentioned, there will be offered for competition an exhibition of 50*l.* per annum for proficiency in natural science; the exhibition to be tenable for three years in case the exhibitor have passed within two years the previous ex-



amination, as required for candidates for honours, otherwise the exhibition to cease at the end of two years.

The candidates for the natural science exhibition will have a special examination on Friday and Saturday the 29th and 30th of April 1870, in

- (1.) Chemistry, including practical work in the laboratory.
- (2.) Physics, viz. 

Electricity.
Heat.
Light.
- (3.) Physiology.

They will also have the opportunity of being examined in one or more of the following subjects:—

- (4.) Geology,
- (5.) Anatomy,
- (6.) Botany,

provided that they give notice of the subjects in which they wish to be examined four weeks prior to the examination.

No candidate will be examined in more than three of these six subjects, whereof one at least must be chosen from the former group. It is the wish of the Master and Seniors that excellence in some single department should be specially regarded by the candidates. They may also, if they think fit, offer themselves for examination in any of the classical or mathematical subjects.

Candidates must send their names to one of the Tutors at least ten days before the commencement of the examination, and if they have not been already admitted members of the College, must send the certificates required previous to admission, viz., a certificate of baptism, and a certificate from some M.A. of Oxford or Cambridge, drawn up in the following form:—

"I hereby certify that I have examined  
"and I consider him qualified both in manners and learning to be admitted a member of the University of  
"Cambridge."

The minor scholarships are open to all persons under twenty years of age, whether students in the University or not, who have not yet commenced residence in the University, or who are in the first term of their residence.

A minor scholarship is tenable for two years, or until the scholar is elected to one of the foundation scholarships.

The exhibitions are not limited in respect to the age of candidates.

It is understood that minor scholars or exhibitors may be candidates for sizarships.

### 13. *Magdalene College.*

[See p. 24.]

### 14. *Trinity College.*

Trinity College Lodge, Cambridge,

14th June 1870.

SIR,

I HAVE to acknowledge the receipt of a circular letter, in which you invite me to state for the information of the Royal Commission, what sums, derived from endowments or parliamentary grants, are applied to the advancement of science or to scientific instruction by this College.

By the word "science," I understand Her Majesty's Commissioners to mean the sciences of experiment and observation, to the exclusion not only of moral and mental, but of mathematical science also, save in so far as regards its application to practical purposes.

Using the word in this popular and restricted sense, I have to report the following contributions, made by the College out of its collegiate revenues, to scientific instruction in the University.

1. We have recently endowed a "prælectorship" (to use the statutable name) in "pure physiology," and appointed a prælector, who receives from our funds about 500*l.* per annum, on condition of delivering lectures during term to the students of this and other colleges. These lectures are to be given *gratis* to our own students, and for a small fee to those not belonging to Trinity.

2. We have made a grant of 400*l.*, also out of yearly revenue, to the prælector for the purpose of procuring scientific apparatus required for the prosecution and elucidation of the science he professes. This apparatus will be placed in one of the public rooms of the University, in the event of permission being given to Dr. Michael Foster\* to deliver his lectures there.

3. We annually offer one or more foundation scholarships for proficiency in the natural sciences. The value of such a scholarship may be put at about 80*l.* per annum,

and it is open to the competition of all undergraduate members of Oxford or Cambridge.

4. We have this year offered to the competition of all members of the University of the standing of Bachelor of Arts or Law, a fellowship on the foundation of the College. This, to a resident, is worth about 350*l.* per annum, rooms and commons included. To a non-resident it is worth upwards of 250*l.*

5. We have recently bestowed a fellowship (as our statutes enable us to do) on a highly meritorious scientific professor\* in the University, whose professorship is understood to be inadequately endowed. This fellowship is tenable *with* the professorship and not otherwise.

6. The College has supplied with the necessary apparatus a lecturer on general physics, including heat and electricity, who, however, derives his salary at present from the "Tristram fund," and not from the revenues of the College. His lectures are open by arrangement to the members of certain other colleges, though primarily intended for the instruction of our own students.

These are the contributions which Trinity College at present makes to the scientific instruction of the College and University. It is fair to add that we have on all occasions professed our willingness, indeed our earnest desire, to allot a per-centage of our divisible revenues for the endowment of professorships in the University, for the building of museums, &c., and the purchase of adequate apparatus. Attempts have more than once been made by the Syndic appointed for the purpose, to induce the other colleges to contribute their quota, but it has hitherto not been found possible to obtain the co-operation of *all* of those bodies. This, I venture to think, would be a perfectly effectual means of extending the instruction given by the University, so as to embrace all the requirements of advancing science. That it is a far more economical method than the endowment of lectureships such as that described in (1.) would be admitted by all competent judges in the University.

I have the honour to be, Sir,

Your obedient servant,

W. H. THOMPSON.

J. Norman Lockyer, Esq.,  
Secretary, &c.

### 15. *Emmanuel College.*

Emmanuel College, Cambridge,

June 23d, 1870.

SIR,

I BEG to inform you, in reply to your letter of inquiry respecting the sums applied at Emmanuel College to the advancement of science, that at this College there is no endowment or grant devoted directly and exclusively to what I understand to be the purpose referred to; but, as it is the desire of the College, in the disposition of its emoluments, to encourage impartially all branches of science and of scholarship, *all* the advantages and rewards of the College are open to students of natural science, and attainable by them on their showing merit in their course of study.

If I could supply you with any special information which could be of service to your purpose, I would gladly do so at any time.

I am, Sir, yours faithfully,

GEORGE PHEAR, Tutor.

(Locum-tenens of the Master of Emmanuel College.)

J. Norman Lockyer, Esq.,  
Secretary, &c.

### 16. *Sidney Sussex College.*

Sidney Sussex College, Cambridge,

14th June 1870.

SIR,

I HAVE the honour to acknowledge the receipt of your printed letter of the 11th inst., requesting me to furnish a statement of all sums applied to scientific instruction or the advancement of science in Sidney Sussex College which are derived from endowments or from parliamentary grants.

I presume that by "science," is meant science other than the "classics, mathematics, and divinity," which have, heretofore, constituted the Cambridge academical curriculum, and to the cultivation of which the whole revenue of this College may be said to have been applied. For promoting the advancement of science, or for aid to scientific instruction in any other or more extended sense, the College has no special endowments, nor has it received parliamentary grants for any purpose whatever.

\* The present "Prælector."

\* The Plumian Professor of Astronomy.



A full statement of the revenue and expenditure of the College was submitted to the Royal Commission of 1860, but I do not understand such a statement to be required by the "Scientific Instruction Commission."

The object of the foundation of this College was, almost exclusively, the education of the reformed Protestant Church of England. The practice of the College, in regard to teaching, has been to accept the general course of study of the University, and to elect as fellows and scholars such of its members as most distinguished themselves therein. The College has by this means always secured a highly competent staff of teachers in those branches of learning which have, heretofore, been held to constitute, in the main, the "higher education."

There appears to have been a general expectation, of late years, that the academical curriculum should be extended and diversified by the admission of various sciences other than mathematical, and in accordance with this expectation, a new honour tripos has, in fact, been established in the University, called the "Natural Science Tripos." This College has encouraged students to become candidates for honours in the tripos. The Royal Commission of 1860 gave the College new statutes, relieving half the number of its fellows from the obligation of taking holy orders. The College may, therefore, reasonably look forward to numbering among its fellows students who have been able to devote themselves exclusively to natural science; and, indeed, it has already shown its desire to fall in with the spirit of the times by having elected a fellow from those who had distinguished themselves in the new honour tripos.

What I wish to make apparent is, that although, as it seems to me, Sidney College has no special endowments for scientific objects in the sense of these new studies, there is every disposition on the part of this College to give a liberal interpretation to the objects of the classical and mathematical endowments of which it is possessed, and to make their application co-extensive with the academical curriculum, whatever that may be or become. And as, when that course was limited, or nearly so, to classics and

mathematics, the elections to fellowships and scholarships for distinction therein supplied the College with a staff of competent teachers, so it may naturally be expected that an equally competent staff of teachers of other subjects will result from making fellowships the reward of high attainments in those subjects, and that the College will thus secure the services of teachers co-operating with the University professors in the various sciences which are engaging the attention of the most able men of the age.

To such a view as this, it may possibly be objected that no one College would be likely to enumerate among its fellows men able and willing to give instruction in so great a variety of subjects; and this objection would be valid were it not that a remedy has been devised, and is, in fact, already in operation, and is perfectly compatible with the maintenance of our collegiate system. Three or four colleges combine and enter into arrangements for inter-collegiate assistance. Thus, for instance, one college having a good chemical laboratory, and a competent lecturer and experimenter in chemistry, receives pupils from other colleges for instruction in that science, sending, in return, to those colleges some of its own students for instruction in other sciences, and so on.

Trusting that the remarks which I have made may not be considered irrelevant to the objects of the Royal Commission on Scientific Instruction, &c.,

I have the honour to be, Sir,

Your obedient servant,

ROBT. PHELPS, D.D.

Master of Sid. Suss. Coll.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### 17. *Downing College.*

[No answer received.]

## II. *Heads of Colleges and Halls in the University of Oxford asked to give evidence.*

On August 4th, 1870, the following letter was addressed, to the Heads of Colleges and Halls at Oxford:—

Aid to Science Commission,  
6, Old Palace Yard,  
Westminster, S.W.,  
August 4th, 1870.

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to transmit to you the accompanying copy of the Royal Commission under the authority of which the Commissioners are conducting their enquiries, and to inform you that they have reached that stage of the proceedings at which it would be convenient that the evidence of the heads of the colleges at Oxford should be taken.

In order that arrangements may be made for taking such evidence immediately after the recess, I am directed to enquire whether you have any facts or suggestions to lay before the Commissioners with regard to College; and to ask if you would be prepared to aid the Commissioners in the prosecution of their enquiry by attending to give evidence in November or December next?

I have the honour to be  
Your obedient servant,  
J. NORMAN LOCKYER,  
Secretary.

The following replies were received:—

#### 1. *University College.*

University College, Oxford,  
November 5th, 1870.

SIR,

I REGRET that some pressing engagements have not allowed me to reply earlier to the communication which you sent to me on October 31st, respecting my attendance on the 22nd inst. before the Commissioners, to give evidence

on the aid given to scientific instruction and the advancement of science in this College.

I beg leave to state that though I should be ready to attend if it should be desired, I should not be able to give any further information than what I have already stated in my answers to a former paper which I had received.

The number of foundation fellowship in this College is small, being 12, one of which is for the present suppressed, in order to raise funds for the augmentation of the scholarships and exhibitions in the College, and these hardly supply a succession in the number of tutors and lectures required for the education in the College.

The number of open scholarships is 12, two of which, lately established by the College, are for proficiency in mathematics or natural science. But these have not yet been offered for natural science, because it was probable from what had occurred in other colleges that very few candidates of sufficient merit would be likely to offer themselves. Only one of our exhibitioners has within the last few years given attention to science, and he obtained a first class on the public examination this year.

If the study of science should be more generally adopted, so that promising candidates would be likely to offer themselves, the College would be ready to offer these two open scholarships to competition, and to provide that they should receive their instruction in such subjects as may be desired from the professors in the University.

If, under these circumstances, it should still be desired that I should appear before this Committee on the 22nd inst., I shall be ready to attend on receiving a notice from you.

I am, Sir,

Your obedient servant,

F. C. PLUMPTRE, D.D.,

Master of University College.

J. Norman Lockyer, Esq.,  
Secretary.



2. *Balliol College.*

Balliol College, Oxford,  
August 5th, 1870.

SIR,

I HAVE the honour to acknowledge your letter of yesterday, and to say in reply that I shall be happy to wait on the Commissioners if they think it desirable. But I have to point out to them that I am no longer Master of Balliol, and am on the point of leaving Oxford for Rochester, and that my successor in the headship of this College will be elected in the early part of next month. Perhaps, therefore, the Commissioners may think it more expedient to apply to him for any information or suggestions regarding Balliol College.

I have the honour to be, Sir,  
Your obedient servant,  
ROBERT SCOTT.

The Secretary,  
Aid to Science Commission.

3. *Merton College.*

[See p. 10.]

4. *Exeter College.*

Exeter College, Oxford,  
August 5th, 1870.

SIR,

I HAVE no facts or suggestions to lay before the Commissioners, but shall, of course, be ready to attend at any time the Commissioners may require, for the purpose of giving evidence.

I have the honour to be  
Your obedient servant,  
J. P. LIGHTFOOT,  
Rector of Exeter College.

5. *Oriel College.*

Precincts, Rochester,  
August 31st, 1870.

SIR,

I REGRET that absence from Oxford, and continual employments at this place, to which your letters of August 4th and 5th have been forwarded, have hitherto prevented my answering them.

1. In reply to your letter of the 4th instant, I can only say that I should be happy to aid the Commissioners in the prosecution of their inquiries if it were in my power; but I do not think that I have any facts or suggestions to lay before them—none at all with regard to Oriel College.

In the University there was a sensibly decreasing attendance upon lectures in physical science during many years after the alterations in the public examinations in 1801 and 1807, and this notwithstanding endeavours on the part of the University authorities to correct the tendency.

But subsequently to the passing a new examination statute in 1850, which established a distinct school in natural science, the attention of the junior students to this department of study has greatly increased, and is, I believe, increasing.

2. With respect to the return desired in your letter of the 5th instant, I do not find that more than two of the junior members of this College were attending classes in natural science during the academical year from October 1869 to July 1870.

3. And to your previous question in June last, what sums derived from endowments or from parliamentary grants are applied to the advancement of science, or to scientific instruction, in Oriel College, I have only to reply that we have no sums of the kind to be applied to these purposes.

But, perhaps, I may add, for the information of the Commissioners, that, as Provost of Oriel College, I am a co-trustee with the Vice-Chancellor of Oxford of a sum (originally 1,000*l.*, but now, by accumulations in former years, increased to 3,200*l.*, in the three per cent. consolidated annuities), bequeathed by Lord Leigh, a former member of this College, for the purchase of instruments for the use of the Professor of Experimental Philosophy in the University of Oxford, and the annual interest of this sum is so applied. But this fund has no reference to the advancement of science in Oriel College itself.

I am, Sir, your faithful servant,

J. Norman Lockyer, Esq.,  
Secretary, &c.

EDWARD HAWKINS,  
Provost of Oriel.

6. *The Queen's College.*

[See p. 11.]

7. *New College.*

New College, Oxford,  
November 4th, 1870.

SIR,

IN reply to the inquiry made in your letter of the 5th of August last, on the part of the "Aid to Science" Commission, I beg leave to state that no lectures on science are given in this College, but that we make arrangements for any students in those subjects to attend the lectures, work in the laboratory, &c., at the University museum; and that the number, therefore, of such students will be included in the returns made from thence. I am not aware that I can assist the Commissioners in their inquiry by further information.

I have the honour to be, Sir,  
Yours obediently,  
J. E. SEWELL, Warden.

8. *Lincoln College.*

Lincoln College, Oxford,  
August 6th, 1870.

SIR,

I HAVE to acknowledge your communication of date 5 August. I beg to say, in reply, that I am prepared to be examined by the Aid to Science Commission in November or December, or whenever summoned.

I am yours obediently,  
MARK PATTISON.

9. *All Souls' College.*

20, Dean's Yard, Westminster,  
August 17th, 1870.

SIR,

I AM not aware that I have any suggestions as to the promotion of the study of science in Oxford to lay before the Commissioners with regard to All Souls' College, but I shall be happy to attend and give evidence in November or December next, if it is thought such attendance can be of any use.

I have the honour to be, Sir,  
Your faithful servant,  
F. K. LEIGHTON,  
Warden of All Souls' College, Oxford.

10. *Magdalen College.*

SCIENTIFIC INSTRUCTION, &amp;c.

THERE was no special endowment under the original foundation of the College for the promotion of natural science, except that there is mention in the statutes of a praelector who might lecture either in divinity or natural philosophy at the discretion of the College officers.

But under the ordinance of 1857 certain fellowships, demys, and exhibitions were set apart for the encouragement of the science of physical study, and four professorships instituted, viz., one in moral philosophy, one in chemistry, one in geology, one in physical geography. Of these, two, viz., the professorships in moral philosophy and chemistry, have been already established, and the remainder will be so as soon as the funds necessary for the purpose have accrued.

The payments, therefore, at present made by the College on behalf of natural science are as follow:—

1. Chemistry professor, at per annum	- £600
5. Demies at 75 <i>l.</i> each per annum	- 375
1. Exhibitioner	- 75
1. Fellowship	- 230
	£1,280

And as funds accrue, two more professorships, as stated above, at a salary of 600*l.* each per annum, and three more fellowships, with an increased number of exhibitions, will be added, making, with the sums already stated, a total of 3,280*l.* 10*s.* per annum devoted to the advancement of physical science.

This, it should be mentioned, is entirely exclusive of the same number of fellowships, demys, and exhibitions, assigned to mathematics.

The demys and exhibitions are open to any person under 20 years of age, without any restrictions as to place of birth or education.

The fellowships are open to any person who has passed the examinations necessary for the B.A. degree in the universities of Oxford and Cambridge. The holders of fellowships in natural science are *not* required to take holy orders.

In addition to this, the College maintains a tutor in natural science, who is placed on the same footing as the classical and other tutors of the College, also a laboratory with an efficient curator, and a library for the use of its natural science students. A sum of at least 250*l.* per annum is required for these objects, of which about 30*l.* per



annum is provided by the interest on 1,000*l.* stock, bequeathed by the late Dr. Daubeny towards the maintenance of the curator, which sum of 1,000*l.* is the only *original* endowment granted or bequeathed for the promotion of the study of natural science in this College.

NOTE.—The number and ability of competitors for the natural science demyships is found to fluctuate very much from year to year, and, in this respect, to show a marked difference from the demyships in classics and mathematics. The removal of the limitation as to age would doubtless in some degree obviate this, and, so far as the College is concerned, be an advantage; but, on the other hand, might tend to discourage candidates from the public and other schools, who would be unwilling to come forward with the knowledge that they might have to compete with persons much older than themselves.

Magdalen College,  
November 4th, 1870.

FREDERIC BULLEY,  
President.

#### DEMYSHIPS IN NATURAL SCIENCE.

In conducting the examination, questions will be put relating to general physics, to chemistry, and to physiology; but a clear and exact knowledge of the principles of any one of the above-mentioned sciences will be preferred to a more general and less accurate acquaintance with more than one.

Candidates have also to satisfy the electors of their ability to pass the ordinary classical examinations required by the University, and for this purpose will have:

a. To translate a passage of English prose into Latin.

β. To bring up for examination—

One Greek author, or a portion, such as five books of Homer, or two Greek plays, or any other equivalent.

One Latin author, or a portion, such as the Georgics, or five books of the *Æneid* of Virgil, or three books of the Odes, and the *De Arte Poetica* of Horace, or any other equivalent.

γ. To answer questions in Greek and Latin grammar.

Very superior excellence, however, in natural science will be allowed to compensate for any deficiency which candidates may have shown in the classical part of the examination.

The stipend of the above demyships is 75*l.* per annum, inclusive of all allowances; but there are tenable with them certain College exhibitions, which raise their annual value on an average to about 83*l.* They are tenable for five years.

No one will be admitted as a candidate who shall have attained the age of 20 years.

Candidates will be required to bring with them a certificate of birth and baptism, with testimonials of good conduct and character, extending over a period of at least three years, from the head master of their school, or from the private tutor with whom they may have been reading.

No entrance fees or caution money are required by the College. The university fees payable on matriculation amount to 2*l.* 10*s.*

#### 11. Brasenose College.

Brasenose College, Oxford,  
October 2nd, 1870.

SIR,  
I BEG to acknowledge the receipt of your letter of August 4th, in which, on behalf of the "Aid to Science Commission," you inquire whether I have any facts or suggestions to communicate respecting Brasenose College, and whether I should be prepared to give attendance on the Commission in November or December next.

I have elsewhere stated, in communication with the Commissioners, that no special provision exists in Brasenose College for the study of physical science.

The comparatively few members who pursue that study, work, and for the most part very diligently, in the University museum, either with a view to the B. A. degree, or with ulterior professional objects.

I do not think that there exists, at present, among our members much taste for science for its own sake, and there is no sufficient demand on the College to require the establishment of a laboratory, without which, I suppose, lectures would be very unattractive, and of little use.

If a demand arose, which possible changes in the scheme of University examinations may promote, I should feel disposed to recommend a combination with other colleges to supply a common want. (We have already arranged with some other colleges for combined lectures in certain other subjects of instruction.)

A separate establishment in each college, except the very largest, would seem, unless under greatly altered circumstances, to be a waste of power.

Feeling that the study of physical science is not in a satisfactory position, I could not decline personally to wait on the Commission, if I had reason to suppose that my evidence could be useful.

I should, however, very much prefer to reply with deliberation, on paper, to any inquiry which the Commissioners may think it convenient to make.

I have the honour to be, Sir,

Your faithful servant,

The Secretary,  
Aid to Science Commission.

E. H. CRADOCK,  
Principal.

#### 12. Corpus Christi College.

Corpus Christi College, Oxford,

August 9th, 1870.

SIR,

IN reply to your inquiry of the 4th inst., I beg to say, that although I am quite willing to assist the Commissioners in the prosecution of their inquiry, I have no facts or suggestions on the subject which I wish to lay before them.

I have the honour to be

Your obedient servant,

JAMES NORRIS,

President of C. C. C.

J. N. Lockyer, Esq.,

Secretary, &c.

#### 13. Christ Church College.

Penmorfa, Llandudno,

August 5th, 1870.

SIR,

I HAVE prepared a paper [see p. 11] stating in full what we have done at Christ Church, Oxford, for the study of scientific subjects and instruction to be given therein. You will have a corrected proof, I hope, on Monday. If my *viva voce* evidence is required in November or December next, I shall be ready to give it, but I should be glad to be informed on what points I am likely to be examined.

I am your obedient servant,

H. G. LIDDELL,

Dean of Christ Church.

To the Secretary of the Science Commission.

#### 14. Trinity College.

[See p. 13.]

#### 15. St. John's College.

[No answer received.]

#### 16. Jesus College.

[No answer received.]

#### 17. Wadham College.

Wadham College, Oxford,

August 6th, 1870.

SIR,

I HAVE the honour to acknowledge the receipt of the Royal Commission transmitted by the direction of the Duke of Devonshire, Chairman, and I beg to assure you, for the information of the Commissioners, that I shall readily attend to their summons at Oxford, and offer such evidence as a very long residence in the University and some interest in the matter of their inquiry may qualify me to give.

I have the honour to be, Sir,

Your faithful servant,

J. Norman Lockyer, Esq. B. P. SYMONS.

Wadham College, Oxford,

November 1870.

SIR,

I AM concerned to say that physical infirmities, of age mainly, will, I fear, preclude my personal attendance on the Commissioners. Of this (my own College), to which you more immediately direct my attention, I am not aware that anything especial, beyond our actual practice, is called for. "Scientific instruction" is provided for students of the College in the several branches recognised in the schools of the University. Nor has "science" failed to receive, in this College, its portion of patronage. Our "scholarships" are always avowedly open to candidates whose pretensions rest on proficiency in "science;" and, from time to time, our election of a scholar is determined exclusively by his scientific attainments. Further, at the last election of a "fellow," we went so far as to limit, by public announcement, the examination of candidates to matters exclusively scientific. More than this, in favour of "science," neither the actual state of the University, nor the preference likely to be given by young men to such studies, would, I think, warrant. Inducements in this direction exist at present fully in proportion to the number of willing students; and any attempt to force the study on unwilling, could not fail to interfere with the legitimate claims of a "liberal education."



"Instruction" and "education" are two very different things, and it is of as much, perhaps more, importance to have the mind well disciplined than even abundantly stored. "Instruction" may be carried to an extent to endanger the great and main purpose of "education."

To any questions the Commissioners may be pleased to put to me, I will readily bring the best consideration that the experience of 20 years as public tutor, and nearly 40 as Head of the College, with a deep interest always in the subject matter of those offices, may have enabled me to give.

I have the honour to be, Sir,  
Your faithful servant,  
B. P. SYMONS,  
Warden of Wadham College.

To Secretary of the  
Commission on Scientific Instruction.

### 18. *Pembroke College.*

Pembroke College, Oxford,  
August 16th, 1870.

SIR, In reply to your letter of the 4th inst., I beg to state that I have no suggestion with respect to this College to lay before Her Majesty's Commissioners, and that I have no fact to add to that which I have already communicated, viz., that we have a medical fellowship in the election to which proficiency in natural science will, in all probability, be always taken into account.

If, under these circumstances, the Commissioners should think proper to summon me, I shall be prepared to attend to give evidence in November or December next.

I have the honour to be, Sir,  
Your obedient servant,  
E. EVANS, Master.

J. Norman Lockyer, Esq.,  
Secretary to H.M. Aid to Science Commission.

### 19. *Worcester College.*

5, Hall Bank, Buxton,  
August 8th, 1870.

SIR, I HAVE no facts or suggestions to lay before the Commissioners of the Aid to Science Commission. But, of course, I shall feel it my duty to attend them in November or December next, if required.

I may be permitted to state that it would be more convenient to me to appear before the Commissioners in November than in December.

I am, Sir,  
Your obedient servant,  
R. L. COTTON,  
Provost of Worcester College.

J. Norman Lockyer, Esq.

### HALLS.

#### 1. *St. Mary Hall.*

[No answer received.]

#### 2. *Magdalen Hall.*

SIR, Crieff, September 19th, 1870.

In answer to the inquiries of the Royal Commissioners, I beg to state that only three students of Magdalen Hall attended "classes in which science was taught," with a view to passing a public examination therein, in the years 1869-1870.

It is not in my power to say how many more may have attended lectures in geology and other branches of science, more or less popular, for general improvement or other objects.

I shall be quite ready to give evidence on all subjects connected with Magdalen Hall "in November or December next," if the Commissioners should wish me to do so.

I am Sir  
Your obedient servant,  
R. MICHELL, D.D.,  
Principal of Magdalen Hall.

J. Norman Lockyer, Esq.,  
Secretary to the Aid to Science Commission.

#### 3. *New Inn Hall.*

[No answer received.]

#### 4. *St. Alban Hall.*

SIR, St. Alban Hall, Oxford,  
August 25th.  
In reply to your printed letter of the 19th, the receipt of which was delayed by my absence from home, I beg to say that I have no facts or suggestions to lay before the Commissioners respecting St. Alban Hall.

I am, Sir,  
Your obedient servant,  
J. Norman Lockyer, Esq. W. C. SALTER.

#### 5. *St. Edmund Hall.*

SIR, St. Edmund Hall, Oxon,  
August 22nd, 1870.  
In reply to your inquiries on behalf of the Aid to Science Commission, I beg to state that no students at St. Edmund Hall attended classes in science during the years 1869-70. I have no facts or suggestions to lay before the Commissioners on the subject, and I presume, therefore, there would be no object in my attending to give evidence before them.

I remain, Sir,  
Yours faithfully,  
E. MOORE,  
Principal of St. Edmund Hall, Oxford.  
To the Secretary, Aid to Science Commission.

### III. *Heads of Colleges in the University of Cambridge asked to give evidence.*

On the 13th December, 1870, the following somewhat similar letter was addressed to the Heads of Colleges at Cambridge:—

Aid to Science Commission,  
6, Old Palace Yard,  
Westminster, S.W.,  
13th December 1870.

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to transmit to you the accompanying copy of the Royal Commission under the authority of which the Commissioners are conducting their inquiries, and to inform you that they have reached that stage of the proceedings at which it would be convenient that the evidence of the Heads of the Colleges at Cambridge should be taken, on the subjects of their inquiry generally, and especially as to whether they are under any legislative disability with regard to the appropriation of their funds.

In order that arrangements may be made for taking such evidence immediately after the recess, I am directed to enquire whether you have any facts or suggestions to lay before the Commissioners with regard to

College; and to ask if you would be prepared to aid the Commissioners in the prosecution of their inquiry by attending to give evidence in the early part of February next?

I have the honour to be  
Your obedient servant,  
J. NORMAN LOCKYER,  
Secretary.

The following replies were received:—

#### 1. *St. Peter's College.*

SIR, St. Peter's College, Cambridge,  
January 23, 1871.  
In reply to your circular letter of 13th December 1870, I beg to state, after consulting the Fellows, that I am not aware of any facts or suggestions, with regard to St. Peter's College, to lay before the Commissioners on Scientific Instruction and the Advancement of Science.



The Master and Fellows have already answered some questions emanating from the Commissioners, and they are ready and anxious to give any further information in their power.

As regards my individual willingness to give evidence before the Commissioners, I shall be most happy to do so if called upon, but I fear that I can add nothing to the information which must have been already given to the Commissioners.

I am, Sir,

Your most obedient servant,  
H. W. COOKSON.

J. Norman Lockyer, Esq.,  
Secretary to the Aid to Science Commission.

## 2. Clare College.

Clare College, Cambridge,  
December 14, 1870.

SIR,

I HAVE the honour to acknowledge the due receipt of your letter of yesterday, addressed to me in the name of the Aid to Science Commission, together with the accompanying copy of the Royal Commission, under the authority of which the Commissioners are conducting their inquiries.

In reply to the question which you put to me, I have to say that, although I have not at present in my mind any facts or suggestions which I am desirous of laying before the Commissioners with regard to this College, I shall be prepared, as far as I may be able, to aid the Commissioners in the prosecution of their inquiry, by attending to give evidence in the early part of February next, if such should be the desire of the Commissioners.

I have the honour to be, Sir,  
Your obedient servant,  
E. ATKINSON,  
Master of Clare College.

J. Norman Lockyer, Esq.,  
Secretary of the Aid to Science Commission.

## 3. Pembroke College.

Pembroke College, Cambridge,  
Dec. 16, 1870.

SIR,

In reply to your letter of the 13th inst., I beg to say that I am not aware that I have any facts or suggestions to lay before the Commissioners with regard to Pembroke College; but that I shall be most happy to aid them in the prosecution of their inquiry to the best of my power, by attending to give evidence in the early part of February next, or in any other way which they may suggest.

I have the honour to be, Sir,  
Your most obedient servant,  
J. POWER.

J. Norman Lockyer, Esq.

## 4. Gonville and Caius College.

Caius Lodge, Cambridge,  
Dec. 17, 1870.

SIR,

I FEAR I shall not be able to add much to the information already laid before the "Aid to Science Commission" in my last letter. [See p. 15.] But I can have no objection to attending before the Commissioners and answering, as far as I am able, any inquiries they may think likely to promote the objects they have in view.

I am, Sir,  
Your obedient servant,  
EDWIN GUEST.

## 5. Trinity Hall.

Trinity Hall Lodge, Cambridge,  
Dec. 30, 1870.

SIR,

At a meeting of the Governing Body of Trinity Hall on Saturday last, I called their attention to your letter to me of the 13th instant.

In reply to it I have to inform you that by the statutes (1860) of this College, it is enabled to make contributions, out of its income, for providing additional means of instruction for the advancement of religion and learning either in the College or the University of Cambridge, but not elsewhere.

In December 1869, a Report of a Syndicate was made, proposing various plans for increasing, by contributions from the Colleges, the income of the University for the purpose of extended instruction in physical science and other subjects.

This College expressed its willingness to adopt the plan No. 1: that is, to contribute 3 per cent. of what is termed its "distributable income," namely, the amount of the stipends of the Masters, Fellows, Bursar, and other officers, provided the other Colleges were willing to make a corresponding contribution. From want of unanimity amongst the Colleges none of the plans of the Syndicate were adopted.

The governing body of this College think it desirable and equitable that the income of the University for the above purposes should be increased by contributions from the Colleges.

The Revd. Henry Latham, Senior Tutor of Trinity Hall, has given much attention to the objects of inquiry referred to by you, and he will gladly attend upon the Commissioners, and state his views on the subject: mine would not further assist the Commissioners, and attendance on them in February would be inconvenient to me.

I am your obedient servant,  
T. C. GELDART,  
Master.

To J. N. Lockyer, Esq.,  
Secretary.

## 6. Corpus Christi College.

Corpus Christi College, Cambridge,  
16th January 1871.

SIR,

I BEG to send you, for the use of the Duke of Devonshire and the other Commissioners, a copy of the Statutes of this College.

There does not appear to be anything in the Statutes "de qualitatibus sociorum et scholarium" to prevent proficiency in science from being taken into account in the election to scholarships and fellowships.

I shall be happy, with the aid of the Tutors and other Fellows of my College, to answer on paper any questions which the Commissioners may have to ask; but I have no facts or suggestions to lay before the Commissioners with regard to scientific instruction; nor do I think that I could give orally any information that would be of service to them.

I am, Sir,  
Your obed. servt.,  
J. PULLING,  
Master.

## 7. King's College.

King's College, Cambridge,  
December 26, 1870.

SIR

I HAVE received your letter of the 13th instant, written under the direction of the Duke of Devonshire, Chairman of the Aid to Science Commission, and with it a copy of the Royal Commission, under the authority of which the Commissioners are conducting their inquiries.

To take the last part of your letter first, I may say for myself, personally, that I have no desire to attend for the purpose of giving evidence to the Commissioners in prosecution of their inquiries; but if it should be thought by them that I could, from my long connexion with the two Colleges of King Henry VI. afford any useful or desirable information, I shall be ready to attend at the Commissioners' call on some day after the early part of February next. I have consulted some senior and official members of the College, with a view of collecting facts or suggestions to be laid before the Commissioners with regard to King's College. The following is a short statement, as the result of my inquiry:—

In answer to the question whether this College is under any legislative disability with regard to the appropriation of its funds, I feel it right to state that, by the present Statutes of the College, which came into operation in April 1861, we are bound to establish, with a due regard to vested interests and the period at which the new Statutes shall come fully into operation, 24 scholarships "appropriated to scholars of the College of King Henry Sixth at Eton," and 24 open scholarships.

Up to the present time, only 21 of the Eton scholarships have been established, and the entire "number of twenty-four Eton scholarships must be completed before any "open scholarships are established."

The College, however, has not been insensible to the propriety of promoting "scientific instruction and the advancement of science."

At the general meeting of the governing body in November last it was agreed that the whole income, now amounting to 881, per annum, arising from land and funds bequeathed



by a former Fellow of the College, one Edmund Vintner, Doctor in Physic, 1685, and directed to be equally divided amongst the 50 Junior Fellows and Scholars of the College, should be appropriated to form a "Vintner" exhibition, to be awarded for proficiency in natural science. Steps have been already taken for obtaining the sanction of the Court of Chancery to a scheme giving effect to such disposition of Dr. Vintner's legacy.

I have the honour to be, Sir,  
Yours very faithfully,  
RICHD. OKES,  
Provost.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### 8. Queen's College.

[No answer received.]

#### 9. St. Catharine's College.

SIR,  
St. Catharine's Lodge, Cambridge,  
18 December 1870.  
I HAVE the honor to acknowledge your letter of the 13th inst., and, in reply, I beg to state that I have no special facts to lay before the Commissioners with regard to St. Catharine's; but that I am prepared to aid the Commissioners in the prosecution of their inquiry by attending to give evidence in the early part of February next.

I shall be obliged if you will furnish me with some information as to the course the inquiry may take, in order that I may be the better able to give the Commissioners such information as they may require.

I have the honour to be, Sir,  
Your obedient servant,  
C. K. ROBINSON.

The Secretary, Aid to Science Commission.

#### 10. Jesus College.

SIR,  
Jesus College,  
14 Dec. 1870.  
IN reply to your letter of yesterday, I have the honor to state, for the information of the Duke of Devonshire, that I have no "facts nor suggestions respecting Jesus College to lay before the Commissioners," of whom his Grace is Chairman; and that I should not be able to lend any "aid to the Commissioners in the prosecution of their inquiry" by personally attending on them early in February, or at any other time.

I have the honour to be, Sir,  
Your obedient servant,  
G. E. CORRIE,  
Master of Jesus College.

J. N. Lockyer, Esq.,  
Secretary, &c.

#### 11. Christ's College.

SIR,  
Christ's College, Cambridge,  
4th January 1871.  
I HAVE had the honour of receiving your letter of December 13th, in which you inform me that the Aid to Science Commissioners have reached that stage of their proceedings at which it would be convenient that the evidence of the Heads of the Colleges at Cambridge should be taken on the subjects of the inquiry generally, and especially as to whether the Colleges are under any legislative disability with regard to the appropriation of their funds; and you inquire whether I have any facts or suggestions to lay before the Commissioners with regard to this College; and whether I should be prepared to aid the Commissioners in the prosecution of their inquiry, by attending to give evidence in the early part of February next.

I shall be most ready to aid the Commissioners in the prosecution of their inquiry in any way that I possibly can. I do not conceive that this College is under any legislative disability in regard to giving special encouragement to Natural Science.

I am afraid that I shall not have many facts or suggestions to lay before the Commissioners; but, if they desire it, I shall be most happy to attend them in February for the purpose of giving evidence.

I have the honour to be, Sir,  
Your faithful servant,  
JAMES CARTMELL,  
Master of Christ's College.

J. Norman Lockyer, Esq.,  
Secretary, Aid to Science Commission.

#### 12. St. John's College.

SIR,  
St. John's Lodge, Cambridge,  
15 December 1870.  
ALTHOUGH I have no special facts which I desire to lay before your Commissioners, yet it will give me pleasure to attend them at any time that they may wish to see me. So far as I can see at present, any day in February, of which I have received some short notice, will be convenient to me.

I beg to remain, Sir,  
Your obedient servant,  
W. H. BATESON.

J. Norman Lockyer, Esq.,  
Secretary, &c.

#### 13. Magdalene College.

SIR,  
Magdalene College,  
Feb. 5, 1871.  
IN reply to your communication of Dec. 13th, I beg to inform you that I have not any facts or suggestions to lay before the Commissioners with regard to Magdalene College.

I am, Sir,  
The Secretary,  
Aid to Science Commission.  
Your obedient servant,  
L. NEVILLE.

#### 14. Trinity College.

SIR,  
Trinity Lodge, Cambridge,  
Dec. 17th, 1870.  
IN reply to your letter of the 13th inst., I beg to say that I shall be happy to attend to give evidence before the Commissioners for promoting science, at such time in February next as may be convenient.

I am not aware that I have any facts relating to this College to communicate beyond that which I had the honor to mention to Her Majesty's Commissioners last autumn in reply to previous communications. [See p. 18.]

The bar to our doing so much as we desire in aiding the scientific teaching of the University, consists in the resistance successfully opposed by other Colleges to the University Commission, in consequence of which they are not empowered by their Statutes to tax their revenues for the purpose in question.

Meanwhile, as already stated, we have appointed, at considerable expense, a Prælector in Physiology, and furnished him with a large sum for the purchase of instruments.

This gentleman has been lecturing in the University Museum to all comers during the term just ended.

I remain, Sir,  
Your obedient servant,  
J. N. Lockyer, Esq. W. H. THOMPSON.

#### 15. Emmanuel College.

SIR,  
Emmanuel College,  
Jan. 7, 1871.  
I AM desired by the Master of Emmanuel College to acknowledge your letter of the 13th ult., and to state that although his health would not allow him to attend to give evidence before the Commissioners, he would be willing to aid the Commissioners by appointing a "Locum-tenens" to answer any inquiry in person which the Commissioners might think it desirable to make respecting Emmanuel College, in furtherance of the objects of the "Aid to Science Commission."

I am, Sir,  
Your obedient servant,  
GEORGE PHEAR,  
Tutor of E. C.  
To J. Norman Lockyer, Esq.

#### 16. Sidney Sussex College.

SIR,  
Sidney Sussex College, Cambridge,  
14th Decr., 1870.  
I HAVE the honour to acknowledge the receipt of your letter of the 13th inst., and to state in reply that I have no particular facts or suggestions to lay before the Commissioners with regard to Sidney Sussex College beyond those which I communicated on the 14th June last. [See p. 18.]

I shall, of course, be ready to attend the summons of the Commissioners, and to give them every information in my power.

I have the honour to be, Sir,  
Your obedt. servant,  
ROBT. PHELPS,  
Master of Sidney Sussex College.

#### 17. Downing College.

[No answer received.]



IV.—*Information respecting Fellowships at the several Colleges in the Universities of Oxford and Cambridge.*

The following Letter, asking for information respecting the Fellowships at the several Colleges at Oxford and Cambridge, was sent to the Heads of the Colleges on the 31st of March 1871.

ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

6, Old Palace Yard, S.W., March 31, 1871.

I AM directed to communicate to you the following resolution, passed by this Commission, and to request that you will be so good as to furnish the return required:—

Resolved—

That each College be requested to give a return, stating—

- I. The whole number of its fellowships.
- II. The date at which its Statutes, as altered by the late University Commission, came into force, and the number of fellowships filled up since that date, divided into two classes:—
  - (i.) The number awarded by the result of a competitive fellowship examination.
  - (ii.) The number awarded for distinction in University examinations, or other proof of merit.
- III. The number of fellowships awarded during the same period for excellence in the subjects—
  - (i.) of Classics;
  - (ii.) of Mathematics;
  - (iii.) of Law and Modern History, or Moral Science;
  - (iv.) of Natural Science.

N.B.—*In case of excellence in more than one of the subjects, the fellowship is to be reckoned under that which is presumed more especially to have influenced the electors.*

IV. A return of the number of fellowships held at the present time—

- (i.) by non-residents;
- (ii.) by residents engaged in the educational work of the College, or of the University;
- (iii.) by residents holding some College or University office not educational;
- (iv.) by residents not belonging to the classes ii. and iii.

I have the honour to be  
Your obedient servant,  
J. NORMAN LOCKYER,  
Secretary.

From the answers returned, the following tabular statement has been drawn up; and some further particulars (which could not be included in this table) follow, respecting the Fellowships at the Colleges marked with a star (\*).

It should be added, that the few particulars given in the table respecting the Fellowships at Jesus College, Cambridge, have been taken from the *Cambridge Calendar*, the Master of that College not feeling himself "at liberty to comply with the request of the Commission."



## RETURN of the NUMBER of FELLOWSHIPS at the several

## Oxford - - - -

COLLEGE.	I. The whole Number of its Fellowships.	II. The Date at which its Statutes, as altered by the late University Commission, came into force, and the Number of Fellowships filled up since that Date, divided into Two Classes :—		
		Date.	(i.) The Number awarded by the Result of a Competitive Fellowship Examination.	(ii.) The Number awarded for Distinction in University Examinations, or other Proof of Merit.
1. University*	Twelve, one being suspended for a limited period under a College Ordinance.	December 14, 1855, and March 4, 1857.	Thirteen - - -	None - - -
2. Balliol -	No return - - -	No return - - -	No return - - -	No return - - -
3. Merton -	Twenty-four; one vacant -	1857 - - -	Seventeen - - -	One - - -
4. Exeter*	Fifteen; including a Probationer Fellowship.	June 27, 1856 -	Eleven - - -	None - - -
5. Oriel -	Seventeen - - -	March 28, 1857 -	Seven - - -	One (a supernumerary Fellowship) conferred, under § 21 of the College Ordinance, upon the Regius Professor of Modern History.
6. Queen's -	Twenty - - -	January 9, 1858 -	Twenty-four - -	None - - -
7. New -	Thirty-eight. By an Ordinance of the 24th of March 1871, the number is to be reduced to 30, as soon as the interests of the College, as a place of education, will permit.	March 19, 1857 -	Eight - - -	One, elected without any competitive examination, as being eminently qualified for the office of tutor, under powers of an addition to the 21st clause of the Ordinance approved by Her Majesty, April 23, 1869.
8. Lincoln -	Twelve; but two are kept vacant, and their proceeds applied to educational purposes, under the provisions of the Statutes of 1855.	1855 - - -	Seven - - -	One by nomination of visitor, in whose patronage it is.
9. All Souls'	Thirty; and, at present, two Supernumerary Fellowships make 32.	April 1857 - - -	Twenty - - -	None can be admitted as candidates for an All Souls' Fellowship, who have either gained a first class, or obtained a prize or Scholarship open to the university.
10. Magdalen -	Thirty (one Fellowship vacant) -	April 1858 - - -	Thirteen, being the whole number awarded since the passing of the Ordinance.	None - - -
11. Brasenose*	At present - - - 13 Suspended for a short time - 2 - 15 (One vacant.)	1857 - - -	Nine - - -	None - - -
12. Corpus Christi -	Twenty; of which one is attached by Statute to the Professorship of Latin Literature, and one to that of Jurisprudence. Three are vacant, of which one is advertised for competition as a "Science" Fellowship.	1866. The first election to an open fellowship under the amended Statutes was in 1866.	Eight - - -	None - - -
13. Christ Church -	On the old foundation 19 Senior Studentships (Fellowships in other Colleges), of which three are also on the new foundation. On the new foundation, established under the Statutes framed by the Commissioners, 18.	Jan. 9, 1858. The first election under the amended Statutes took place Dec. 17, 1859.	Twenty - - -	Two (from University distinctions and testimonials from Professors, especially for educational purposes).
14. Trinity -	Twelve, including one suspended	1857 - - -	Twelve - - -	One - - -
15. St. John's -	Thirty (one Fellowship being vacant).	1861 - - -	Seven - - -	One - - -
16. Jesus* -	Fourteen. In future 13, when one Fellowship will have been commuted into Scholarships.	April 4, 1857 -	Nine. No fellowship has been filled up without examination.	- - -
17. Wadham*	Fourteen; one having been suppressed by the late University Commission, to augment the salary of the Professor of Experimental Philosophy.	June 1867 - - -	Four; all after public advertisement.	- - -
18. Pembroke*	Ten - - -	Partially in 1858, and completely in 1861.	Four - - -	One (on the ground of University distinction and usefulness to the College).
19. Worcester*	Seventeen - - -	March 19, 1857. The first election under the new ordinance took place in 1864.	Four - - -	- - -



## COLLEGES in the UNIVERSITIES of OXFORD and CAMBRIDGE.

## Oxford.

III. The Number of Fellowships awarded during the same Period for Excellence in the Subjects:—				IV. A Return of the Number of Fellowships held at the present Time:—			
Of Classics.	(ii.) Of Mathematics.	(iii.) Of Law and Modern History, or Moral Science.	(iv.) Of Natural Science.	(i.) By Non-Residents.	(ii.) By Residents engaged in the Educational Work of the College, or of the University.	(iii.) By Residents holding some College or University office not Educational.	(iv.) By Residents not belonging to the Classes ii and iii.
elve	One	None	None	Six	Five	None	None.
return	No return	No return	No return	No return	No return	No return	No return.
irteen	Two	None	One	Eight	Ten	Three	Two.
note a.	Three	None, exclusively; but see note a.	None	Five	Eight, inclusive of one who has a lectureship in another college.	One, the chaplain, elected under the old statutes. Under the new statutes, the servants of the college, young and old, are, specially in educational matters, and otherwise, placed under the Chaplain's care. One, by the Vicar of the parish of St. Mary the Virgin, Oxford, in the patronage of the College, and of which the College is Rector.	One.
	One (partly for Physics.)			Ten	Six		—
teen	Four	None	One	Eight	Nine	One	Two.
ht	One	The subjects of examination for the Fellowships have been mainly those recognized in the classical and mathematical schools of the University, but opportunity has been given to candidates to offer themselves for examination in law and modern history, and in physical science.		Thirty-one	Five	One	One (being until March 31, 1871, a Probation Fellowship).
en (Classical and Moral Science combined in equal portions.)				Six	Two	One	One.
ic	None	Twenty (Law and Modern History).	None	Twenty-seven (but of these, most are resident occasionally for a few days).	Four	None	One.
(i. and iii. combined).	Two	(Papers on Law and Modern History, or Moral Science, are always given in the examination, No. 1.)	One	Seven; occasional residents, five.	Eleven	Three	Three.
(Classics and Moral Science).	One (for Mathematics only).			Four	Eight.	—	—
note a.	Two (for Mathematics, with a Paper on Natural Science). See note b.						
	One	One (Law and Modern History).	None	Ten	Five; in addition to the two held by the Professors (already mentioned).	—	—
en (including also History and Moral and Natural Philosophy).	Two		Four	Two (of these one will vacate his studentship within the next twelve months).	Eleven	One	Four. (Of these two are preparing to give lectures in Oxford in October next.)
Enn (Classical and Moral Science).	One			Six	Four	One	None.
ic	Two	None, save only that some degree of competency in these subjects had influence in the election of those who were chosen for proficiency in Classics.	None, except so far as mixed Mathematics involve an acquaintance with Physical Science.	Fourteen	Six	Six	Three.
ic	One			Seven	Six. (Two of these are also engaged in College employment not educational.)		One, in his year of probation.
ic (Classical History, and Moral Philosophy combined).			One	Seven	Five	One	One.
Two combined with Moral Science).	One	One (Modern History combined with Classics).	One (combined with Mathematics).	Four	Six.	—	—
For Classics and Moral Science).				Eleven	Three	Three.	—



## Cambridge

COLLEGE.	I. The whole Number of its Fellowships.	II. The Date at which its Statutes, as altered by the late University Commission, came into force, and the Number of Fellowships filled up since that Date, divided into Two Classes:—		
		Date.	(i.) The Number awarded by the Result of a Competitive Fellowship Examination.	(ii.) The Number awarded for Distinction in University Examinations, or other Proof of Merit.
1. St. Peter's	Fourteen	August 27, 1860	None	Seven
2. Clare	Eighteen, including one founded about a year ago. ( <i>One Fellowship vacant.</i> )	April 16, 1861	None	Thirteen
3. Pembroke	Thirteen; and one Bye-fellowship, which will expire with the present holder. ( <i>One Fellowship vacant.</i> )	April 16, 1861	None	Eight, and one, under a new Statute great scientific distinction.
4. Gonville and Caius	Thirty-two	June 30 and August 27, 1860; and April 16, 1861.	None	Fifteen
5. Trinity Hall	Thirteen. ( <i>Two vacant.</i> )	1860	None	Eight
6. Corpus Christi	Twelve	April 1861	None	Eight
7. King's*	Fifty, to be reduced to 46 by the New Statutes.	1861	None	Seven
8. Queen's	Fourteen	June 30, 1860	None	Seven. One Fellowship has been awarded to the Professor of Arabic on account of his merits as a Semitic Scholar.
9. St. Catharine's	Nine	May 10, 1860	None	Seven
10. Jesus		1862		
11. Christ's*	Fifteen	May 30, 1860	None	Twenty-one
12. St. John's	Fifty-six ( <i>one Fellowship vacant</i> )	February 22nd, 1860	Since that date to the present time 69 vacant Fellowships have been filled up at 11 several elections. In each case there was competitive examination, and regard was also paid to distinction in College and University examinations, as well as to other proof of merit.	
13. Magdalene	Five; to be increased to eight	1860	None	Five
14. Trinity*	Sixty ( <i>three Fellowships vacant</i> )	June 26th, 1861	Fifty-six	One, without examination, and for services rendered to the University as a Professor.
15. Emmanuel*	Twelve ( <i>Foundation Fellowships</i> ) two vacant.	1861	None	Seven
16. Sidney Sussex*	Nine	1860	None	Four
17. Downing	Eight; two not filled up	October 24th, 1860	None	Three



## Cambridge.

III. The Number of Fellowships awarded during the same Period for Excellence in the Subjects:—				IV. A Return of the Number of Fellowships held at the present Time:—			
(i.) Of Classics.	(ii.) Of Mathematics.	(iii.) Of Law and Modern History, or Moral Science.	(iv.) Of Natural Science.	(i.) By Non-Residents.	(ii.) By Residents engaged in the Educational Work of the College, or of the University.	(iii.) By Residents holding some College or University Office, not Educational.	(iv.) By Residents not belonging to the Classes (i.) and (ii.)
Five . . .	Two . . .	None . . . . .	None . . . . .	Seven . . .	Two . . . . . N.B. Two others take private pupils.	None : distinct from those specified in (i.), but both those.	Two, who are employed in private tuition, and are mentioned in N.B. (ii.)
Five, one of the Fellows elected being also distinguished in Moral Science.	Eight, one of the Fellows elected being also distinguished in Natural Science.	None for excellence solely in these subjects.	None, solely for excellence in Natural Science.	Eight . . .	Five, including the college dean.	None . . . . .	Four. These are all young Fellows, pursuing professional studies.
Three . . .	Six . . . . .	None . . . . .	None . . . . .	Four . . . . .	Six . . . . .	One . . . . .	One; engaged as a private tutor.
Two . . . . .	Thirteen . . .	None . . . . .	None . . . . .	Twenty-one . .	Nine . . . . .	Two . . . . .	None.
Two . . . . .	Five . . . . .	One to be Professor of Political Economy.	. . . . .	Six . . . . .	Five . . . . .	None . . . . .	None
Two, and one double first in Classics and Mathematics.	Five . . . . .	None . . . . .	None . . . . .	Three . . . . .	Six . . . . .	Two . . . . .	One
Seven . . . . .	None . . . . .	None . . . . .	None . . . . .	Thirty-eight . .	Three . . . . .	Seven . . . . .	Two.
One . . . . .	Six . . . . .	None . . . . .	None . . . . .	Nine . . . . .	Three . . . . .	None . . . . .	One; engaged as a private tutor.
Two . . . . .	Five . . . . .	None . . . . .	None . . . . .	Six . . . . .	Two; one vacant, to be filled up shortly.	None . . . . .	None.
Four . . . . .	Four . . . . .	None . . . . .	None.	— . . . . .	— . . . . .	— . . . . .	—
See Note a. . .	See Note a. . .	None . . . . .	None . . . . .	Eight . . . . .	Four . . . . .	Two . . . . .	One.
Twenty-four, four of the successful candidates having obtained a first class in other departments.	Forty-one, two of the successful candidates having obtained a first class in other departments.	Two; one of the successful candidates having obtained a first class in mathematics. Of the remaining two of the sixty-nine, one was awarded for a Theological Work of remarkable ability; the other for distinguished attainments in Oriental Language and Oriental Literature.	. . . . .	Twenty-six . . .	Thirteen . . . .	Six . . . . .	Ten; of these seven are engaged in educational work unofficially.
Three . . . . .	Two . . . . .	None . . . . .	None . . . . .	Two . . . . .	Three . . . . .	None . . . . .	None.
See Note a. . .	See Note a. . .	See Note a. . .	One . . . . .	Thirty. See Note c.	Eighteen . . . .	Four . . . . .	Five. See Note b.
Four . . . . .	Three . . . . .	None . . . . .	None . . . . .	Five . . . . .	Four . . . . .	One (the Junior Fellow).	None.
None . . . . .	Two . . . . .	None . . . . .	Two . . . . .	Five . . . . .	Four . . . . .	None . . . . .	None.
Two . . . . .	None . . . . .	None . . . . .	One . . . . .	Four . . . . .	Two . . . . .	None . . . . .	None.



## OXFORD.

## 1. University College.

University College,  
June 17, 1871.

II. The Ordinances framed by the late University Commissioners and altering the College Statutes are dated December 14th, 1855, and March 4th, 1857 respectively. They did not, however, take effect until approved (shortly afterwards) by Her Majesty in Council. Thirteen fellowships have been filled up since December 14th, 1855, all of which without exception have been awarded by the result of a competitive fellowship examination.

III. During this period, no fellowship has been awarded for excellence in the subjects of (iii.) Law and Modern History or Moral Science, or (iv.) Natural Science, exclusively; one fellowship has been awarded for excellence in the subject of (ii.) Mathematics exclusively. In awarding the other twelve fellowships weight has been given not only to excellence in the subject of (i.) Classics, but also in the subjects of Ancient and Modern History and of Mental and Moral Science, and (on two occasions) of Mathematics.

[N.B.—There is a bye-fellowship (the “Stowell Civil Law”), not reckoned among the fellowships of the College, in awarding which very great weight is given to the subjects of Law and Modern History.]

IV. Of the twelve fellowships of the College, one is temporarily suspended; (i.) six are held by non-residents; (ii.) five by residents engaged in the educational work of the College (one such resident being a probationer fellow). None of the residents belong to class (iii.), nor (exclusively) to class (iv.).

G. G. BRADLEY, Master.

## 4. Exeter College.

Note a.—Eleven fellows have been elected under the new statutes; three, as stated, for mathematical excellence (one of the three, however, having obtained a first class in natural science), and eight for other excellence. The Rector is unable to state with any accuracy what weight a knowledge of Classics or of Modern History or of Moral Science has had in each election. Papers were set in all three subjects, and probably four of the eight fellows elected may have owed their election chiefly to Classical Knowledge; the other four chiefly to a knowledge of one or both of the other subjects mentioned.

J. P. LIGHTFOOT,  
Rector of Exeter College.

Exeter College, April 3, 1871.

## 11. Brasenose College.

Note (a).—In electing to the so-called classical fellowships, Moral Sciences may be supposed, on the average, to have influenced the electors in at least an equal degree with Classical Knowledge.

In most cases the examination has included questions in Modern History.

Note (b).—These two fellows were elected mainly for their excellence in Mathematics.

E. H. CRADOCK, Principal.  
Brasenose College, April 23, 1871.

## 16. Jesus College.

The number of fellowships elected to since April 4, 1857, is nine, but of these one was competed for by candidates who had a vested interest; the examination for that one, and for seven of the other eight was classical. The examination for one fellowship was mathematical. Two of the seven elected on classical examination were successors to two others of the seven, who soon vacated their fellowships. Of the seven non-resident fellows, two have only recently taken livings to which they retired in 1870; they are now fellows in their year of grace.

One other is now in India in furtherance of a special provision of the will of the founder, which directs that the fellow when employed abroad should be considered as having all the titles and claims of a resident fellow.

CHARLES WILLIAMS,  
Principal of Jesus College, Oxford.

April 24, 1871.

## 17. Wadham College.

II. The first election of a fellow under the Ordinance of the late University Commission was in June 1867. Four fellows have been elected under that Ordinance, and all after public advertisement, as the result of an open competitive examination.

III. (1.) Three have been elected for combined excellence in “Classics, History, and Moral Philosophy,” but by which of those subjects each elector may have been “especially influenced,” it is not possible to say.

(2.) One for excellence in “Natural Science” exclusively. It was found upon the general notice of an election to a fellowship, that candidates who rested their pretensions mainly or entirely on attainments in some specified branch of science, rarely offered; and on the last occasion but one, we announced that the exercises would be confined to certain specified branches of science. No exercises, therefore, were given in “Classics, History, or Moral Philosophy,” and the election was made accordingly.

It may not be inappropriate to observe that some of the specified sciences had not been the favourite studies in Oxford, that, in fact, there were few who had devoted themselves to them, or were prepared to place their main hopes of distinction on eminent attainments in them. The supply, therefore, was hardly adequate to the increased demand; and there was the danger of introducing and establishing a low standard of attainment for excellence. A great change in intellectual taste, or in the relative estimate of distinction in educational pursuits cannot be effected at once.

One fellowship is vacant.

B. P. SYMONS, Warden.

Wadham College, April 20, 1871.

## 18. Pembroke College.

Pembroke College, Oxford, June 2, 1871.

BEFORE I reply to the questions addressed to me by the Commission on Scientific Instruction, I beg to state that I feel some difficulty with respect to those contained under Section III., because, at best, I can only give my own impressions in those cases in which candidates have been examined in two or more subjects—and we have never examined in one only—and because my impressions as to the relative weight of the different papers in determining my own choice are by no means clear. Therefore, my answers under this head must not be taken as of much value in the way of statistics. I also wish to explain that in answering II. (ii.), I have treated the exercise of the power given to us by our new Ordinances, § 22, of retaining a Fellow who shall have vacated his Fellowship by marriage or otherwise, if he shall be a professor or public lecturer in the University, as an election.

E. EVANS, Master.

## 19. Worcester College.

Worcester College, May 19, 1871.

THERE is one resident Fellow holding a non-educational office (bursarship) which is held with educational offices. There is one holding the vice-provostship, and one holding the deanship, also with educational offices.

R. L. COTTON, Provost.

## CAMBRIDGE.

## 7. King's College.

King's College, Cambridge, April 3, 1871.

I. The number of fellowships as constituted by the new statutes of this College is “forty-six.”

The present number of Fellows in the College is “fifty,” the excess being caused by the large number of vested interests remaining to be satisfied under the old system when the new statutes were passed.

RICHD. OKES, Provost.

## 11. Christ's College.

Christ's College, Cambridge, June 19, 1871.

a. III. The following table will show the University honours which have been gained by the Fellows elected since May 30, 1860.

It may be premised that no fellowships have been awarded for excellence in law and modern history, or moral science, or natural science.

Also, that in University, mathematical, and classical honours, the candidates are arranged in each of the three classes in the order of merit; and in theological honours, in each of the three classes alphabetically.



A.D. Date of Degree.	Mathematical Honours.	Classical Honours.	Theological Honours.
1. 1800	42nd Senior Optimo -	1st, first class; bracketed equal with two others. Also 1st Chancellor's Medalist, bracketed equal with another.	—
2. 1858	14th Wrangler -	—	First class.
3. 1859	15th Junior Optimo -	4th, first class.	—
4. 1861	4th Wrangler -	—	—
5. 1861	33rd Senior Optimo -	7th, first class.	First class.
6. 1862	5th Senior Optimo -	7th, first class.	—
7. 1861	—	9th, first class.	—
8. 1862	—	12th, first class.	First class.
9. 1863	12th Wrangler -	—	—
10. 1865	—	8th, first class.	—
11. 1865	27th Wrangler -	6th, second class.	—
12. 1866	Senior Wrangler; also 1st Smith's Prize-man.	—	—
13. 1868	Senior Wrangler; also 1st Smith's Prize-man.	—	—
14. 1868	9th Wrangler -	—	—
15. 1868	—	2nd, first class.	—
16. 1869	2nd Wrangler; bracketed equal with two others.	—	—
17. 1869	5th Wrangler -	—	—
18. 1869	36th Senior Optimo -	1st, first class; bracketed equal with another. Also 1st Chancellor's Medalist.	—
19. 1869	—	10th, first class.	First class.
20. 1870	—	1st, first class; bracketed equal with another.	—

21. In addition to these, a former fellow, who had vacated his fellowship by marriage, was re-elected on account of his high academic distinction and literary merits.

IV. (i.) At the present time eight of the fellows are non-resident (one of them on account of ill-health); and seven are resident.

Of the seven resident fellows—

(ii.) Four are engaged in the educational work of the College.\*

(iii.) Two are engaged in College or University offices not directly educational, one of them being also partly engaged in private tuition.

(iv.) One is engaged in private tuition, and is also an Assistant Curate in the parish of Chesterton, adjacent to Cambridge.

JAMES CARTMELL,  
Master of Christ's College.

#### 14. Trinity College.

Trinity College, Cambridge.

(a.) IN reply to question III., I beg to say that our Fellows are elected without regard to the results of the University examinations, but with regard to their performances in an examination held during five days in the College Hall. The subjects of this examination are varied, embracing Classics, Mathematics, Moral and Metaphysical Philosophy, Political Philosophy, Logic and Political

\* NOTE.—In addition to these, two former fellows are also engaged in the educational work of the College.

### APPENDIX VII. (See Question 2891.)

LIST of POSTS in NATURAL SCIENCE filled by men who have passed through the Physical Science Schools at Oxford.

	No.		No.
<b>Fellowships in Natural Science:</b>		Lectureship on botany at St. George's Hospital	1
Open Fellowship at Merton	1	Do., on medical chemistry, University Museum, Oxford	1
Do. Magdalen	1		
Do. Queen's	1	<b>Professorships:</b>	
Do. Pembroke	1	Chemistry at Cirencester College	1
Do. Wadham	1	Botany, Royal College of Science, Dublin	1
Do. Oriel	1	Hygiène at University College, London, held by Fellow of Pembroke	0
Do. Corpus Christi	1	Geology, Owens College, Manchester	1
Open studentships at Christ Church, called Lee's	3		
Readers	10	<b>Masterships:</b>	
		Physical Science mastership at Eton College, held by Fellow of Queen's	0
<b>Mathematical Fellowships filled by men who have also passed through the Physical Science School:</b>		Do. at Harrow School	1
Open Fellowship at Exeter	1	Do. at Clifton College	1
Do. University	1	Do. at Rossall School	1
Do. called studentship, Christ Church	1		
Do. St. John's	1	<b>Assistants:</b>	
<b>Lectureships:</b>		To Professor Rolleston	3
Physical Science Lecturer at Magdalen and Jesus Colleges	1	" " Acland	3
Do., at Merton, held with the Fellowship	0	" " Brodie	2
Lectureship in morbid anatomy at St. Bartholomew's Hospital	1		
Do., at St. Thomas's Hospital, held by the Fellow of Magdalen	0	Geological Survey	2

Economy. Essays are also written on literary or scientific subjects. Of the nine electors each has one vote, which he exercises subject to no enquiry as to the grounds of his preference; nor is any record kept of the reasons for which any candidate may have been chosen. It is only known that he seemed to the majority of the electors more fit than any of the unsuccessful candidates to be elected a Fellow of the College "as a place of Religion, Learning, and Education."

In one instance only has a Fellow been elected on the avowed ground of his superiority in a special examination, conducted by experts in the so-called Natural Sciences.

A more precise answer to this third question it is not in my power to give.

(b.) One of these was appointed to an educational office, which is in abeyance owing to his dangerous illness. He resided in the Michaelmas and Lent terms. Three residents live out of College, but within the precincts of the University.

(c.) Of the non-residents, three are prevented from residing by more or less serious maladies; four hold Government appointments; one is Professor of Mathematics in an Irish College; one is an Incumbent in his "year of grace;" four have the care of parishes; one or two are masters in public schools; and nearly all the rest are law students or barristers of less than seven years' standing. Of those in Government employ, three out of four have served the College in the capacity of Assistant Tutors, and one as Tutor and Bursar as well.

W. H. THOMPSON, Master.

Cambridge, May 31, 1871.

#### 15. Emmanuel College.

THERE are now two Fellowships vacant, which will be shortly filled up.

It has been the custom of the College to elect to its fellowships from its own members, provided that amongst them were students of sufficient University distinction. Hitherto there have been no candidates in the College, exclusively students of Natural or Moral Science who have been thought to come up to the usual fellowship standard of ability.

S. G. PHEAR, B.D.,

May 1, 1871. Fellow and Tutor.

#### 16. Sidney Sussex College.

Sidney Sussex College, April 5, 1871.

As the above information is calculated to mislead on the very important point of amount of teaching force employed in this College, I think it right to add that there would be ample employment for all the Fellows. It is found, however, in practice, more convenient and satisfactory to allow such Fellows as prefer it to go out of residence, and to engage other resident members of the University, whether of the College or not, to fill up the staff. Of such there are always a great number willing to be so employed. At present several very distinguished men are engaged in this College, in addition to the four resident Fellows, so that the staff is a very strong one and of the highest competency.

ROBT. PHELPS, D.D., Master.



## APPENDIX VIII. (See Question 2928.)

LETTERS from the CHAIRMAN of the ENDOWED SCHOOLS' COMMISSION to the VICE-CHANCELLORS of the UNIVERSITIES of OXFORD and CAMBRIDGE.

Endowed Schools' Commission,  
2, Victoria Street, S.W.

REV. SIR,

June 3, 1870.

I HAVE the honour, on behalf of the Endowed Schools' Commissioners, to communicate to you a copy of a letter addressed by me to the Vice-Chancellor of the University of Oxford on an important subject which appears to them equally to concern the other English Universities, and to express the hope that you will take such measures as you may think fit for bringing it under the notice of the University of Cambridge. Accidental circumstances made the present a convenient time for approaching the University of Oxford, and we are unwilling that there should be any delay on our part in asking for the subject the attentive consideration of the body over whom you preside.

I am, &c.,

The Rev. the Vice-Chancellor,  
Cambridge.

LYTTELTON.

(Copy.)

Endowed Schools' Commission,  
2, Victoria Street, S.W.

REV. SIR,

June 3, 1870.

1. I VENTURE, on behalf of myself and my colleagues on the Endowed Schools' Commission, to address you on a subject of great importance to the work which has been confided to us, and which may also, in itself, be of moment to the several English Universities. We have learnt that the Congregation of the University of Oxford has recently appointed a Committee of its own body to revise their system of examinations. We conceive, therefore, that, independently of the necessity for action which presses on ourselves, the time may be favourable for approaching the University with reference to a question which, as it affects a portion at least of the higher education of the country, is closely connected with the action of the Universities.

2. That the course of study insisted on by the Universities must to a great extent govern the course adopted in the higher schools is a proposition which will probably be accepted without argument. Though it may be the case that only a very few scholars are intended for the University, those few are the most prominent, stay the longest, and give a bias to the whole education of the place, and numbers of schools are thus forced or irresistibly attracted into a course of study which is not that best suited to the bulk of those for whom they are designed.

3. The practical result is, that the study of the Greek and Latin classics becomes the highest aim of all great schools, an end to which the old system is adapted, and which has hitherto overshadowed and dwarfed all efforts in other directions.

4. We do not propose to discuss here the question whether the Greek and Latin languages are the finest and most efficient organs of mental training. We merely rest upon the fact that many competent judges say that they are not, and that very large numbers of the middle classes in England view with suspicion, if not with aversion, the predominance of these subjects in the ordinary school course. This suspicion or aversion may not always be very intelligent, or founded on clearly assignable reasons, but it is instinctive, it is widely spread, it tallies with the undoubtedly intelligent judgments above referred to, and the fact of its existence is a reason for endeavouring to establish other alternative and additional modes of training, more acceptable to at least a large number of people. The state of opinion is such as to leave no room for doubt that these newer methods will be followed by many who, if they cannot find sufficient aid in this country, will have recourse, as some are now doing, to Germany and other foreign countries.

5. We start, then, from the fact that there exists a strong demand for more training by other than classical studies, and that the subjects generally suggested for this purpose are mathematics, modern languages, and natural science.

6. Mathematics have a recognized footing in the country; they have long been the leading study at Cambridge, and are a fully established study at Oxford, and we do not think it necessary to dwell upon them.

7. The advantage of modern languages for practical use is obvious enough; and there are many who think they may be made an excellent organ of mental training. It will be sufficient on this head to refer to the Schools' Inquiry Report, pp. 25-28.

8. The evidence in favour of natural science is stronger still. We would refer to the same report, p. 34, and to a

Report made in the year 1867 to the British Association, which will be found published by the Schools' Inquiry Commission in vol. II. p. 219. It is clear that amongst highly-educated men who have studied the subject deeply, there are some who think that both for the practical nature of the knowledge it conveys and for its severe training of the whole range of mental faculties, natural science has a higher claim than any other subject to be the chief instrument of education.

9. It appears to us, as it appeared to the Schools' Inquiry Commissioners (Report, p. 87), that a demand made by so many parents and supported by strong proof of its reasonableness ought to be ungrudgingly conceded. The question for us is not so much whether the demand should be met, as what measures are required to give it practical effect. It is not enough to establish schools with what may be called a modern curriculum, but intended only for those scholars who terminate their school career at 14 or 16 years of age; for the time does not allow of a fair trial of the new methods, nor would such schools meet the want of the more intelligent part of the parents who make the demand. Nor is it enough to add the modern studies to the ordinary classical curriculum in higher schools, for that involves the dangerous risk of distracting the minds of the pupils and dismissing them with a smattering instead of a solid hold of knowledge, and of encouraging habits of skimming over a variety of surfaces instead of grappling closely with difficulties. Nor can the ancient and modern studies be wisely put as rival objects of pursuit in the same school, with the almost inevitable result of the supremacy of the one, and the decay of the other. For, as experience has shown, the one to decay is that which has not got on its side long usage, or established reputation, or the associations of old institutions, or the sympathies of the great body of teachers, or the substantial attractions of endowments.

10. We are convinced that in order to give fair trial and full play to the study of modern languages and natural science, it is necessary to establish some schools of the first grade (i. e., schools retaining their scholars to the age of 18 or 19), in which these subjects should be the staple of the course of study, and to that end the time and importance assigned to classics be much diminished.

11. Nor can we doubt which part of the ordinary curriculum should be sacrificed for this purpose. Something not inconsiderable may no doubt be done by dropping some of the elegancies of Latin scholarship and teaching that language more with a view to a knowledge of its structure and the capacity of understanding its literature than with a view to composition. But that Latin should in the main be retained, we do not question. If modern languages are to be studied, Latin lies at the base of Italian, Spanish, and French, and enters largely into English. Its practical use in life is appreciable: until within the last four centuries Latin was the language in which the largest part of the business of Western Europe was recorded, and almost the whole of its literature was written. No ecclesiastic, lawyer, antiquarian or physician can dispense with all knowledge of it. Greek has none of these uses, while yet it takes more time to learn, is forgotten sooner, and is the object of greater suspicion and dislike to parents. It belongs to the classical region and to that alone; and from its difficulty, and also its attractiveness, must be expected to receive a large share of the students' time and attention, if it is to answer any sufficient purpose. No school can be other than a classical school in which Greek is effectively studied.

12. Influenced by these considerations, we have determined to venture on the experiment of employing some of the educational endowments best adapted for the purpose in establishing among other schools of the first grade, some which may by way of distinction be called *Modern*: that is, schools in which Greek shall be excluded in order to provide adequate test and encouragement for the study of modern languages and natural science.

13. When, however, we propose to establish such schools we are met by the objection that the Universities will be closed to the pupils, however competent, unless they will spend money and time in acquiring that quantum of Greek which is exacted from all who go there. The quantum itself is not great, and might doubtless be acquired perfunctorily and, according to the common phrase, by "cram;" but in that case it would be of little value for the purpose of mental training, and the exertion spent in acquiring it would be almost pure waste in a life which may have little to spare.

14. The broad result is, that as long as Greek is made a *sine quâ non* at the Universities, those schools of the new



type which it is proposed to establish will labour under the serious disadvantage of being cut off from direct connection with the Universities through a want of agreement in their course of studies with University requirements, while, if the schools flourish, the Universities will in some degree lose their control over a portion of the higher culture of the nation.

15. We trust that we shall not be understood as desiring to intrude speculations of our own concerning the internal arrangements of the Universities. But we are confident in the belief that, for our own work, we are bound to attempt to establish such schools as we have indicated; and it is with reference to them that we venture to suggest to the Universities to modify those arrangements, so that, for instance, a first-rate man of science who knows no Greek shall not (at least in theory and intent) be at any

greater disadvantage than a first-rate Greek scholar who knows no science. How this is to be done, we do not pretend to suggest; but if once the object be considered desirable, we presume that no great practical difficulty will be felt in giving effect to it by those who are familiar with the details of University organization.

16. We shall be much obliged if you will be kind enough to bring this matter before the recently-appointed Committee, or before any more competent authority; or to inform me whether there is any more appropriate mode in which we can approach the University on this topic, than through yourself.

I am, &c.,  
(Signed) LYTTELTON.

The Rev. the Vice-Chancellor,  
Oxford.

## APPENDIX IX. (See Question 2949.)

NUMBER OF STUDENTS attending Science Classes during the Session 1869-70.

The following letter was sent, on the 5th August 1870, to the English, Scotch, and Irish Universities, University College and King's College, London, Royal School of Mines, London, and Owens College, Manchester:—

Aid to Science Commission,  
6, Old Palace Yard, Westminster, S.W.,  
August 5th, 1870.

SIR,

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to state that the inquiries of the Royal Commissioners would be much aided if they had before them a return of the number of students attending any classes in which science was taught during the session 1869-1870.

I am, therefore, directed to ask you to be so good as to further the inquiries of the Commissioners by causing such a return to be prepared and forwarded to me as soon as possible. The return should not include pure mathematics or moral science; and it is of importance that it should embrace only those students who are attending at any one time.

I have the honour to be, &c.,  
J. NORMAN LOCKYER,  
Secretary.

From the returns received, the following table has been compiled:—

RETURN of the NUMBER of STUDENTS attending SCIENCE CLASSES during the Session 1869-70.

### ENGLAND.

#### OXFORD.

##### UNIVERSITY.

Attending the lectures of the Regius Professor of Medicine (Dr. Acland)	-	-	-	[No return.]
Attending the lectures of the Savilian Professor of Astronomy (only a short course given in May 1870)	140			
Attending the lectures of the Sedleian Professor of Natural Philosophy (Rev. Prof. Price)	-	-	-	[No return.]
Attending the lectures of the Professor of Botany (Prof. Lawson)	-	-	-	30
Attending the lectures of the Professor of Experimental Philosophy (Rev. Prof. Clifton):				
Michaelmas Term, 1869, number of names on register	-	-	-	38
[N.B.—Only fresh students are obliged to sign the register; many students who have previously joined the class do sign, but not all.]				
Lent Term, 1870	-	-	-	33
Easter and Trinity Term, 1870, laboratory class	-	-	-	5
[N.B.—But few students could be received in these Terms, in consequence of alterations in the rooms, necessitated by the removal of the department to new buildings.]				
Attending the lectures of the Professor of Chemistry (Sir B. C. Brodie, Bart.)	-	-	-	[No return.]
Attending the lectures of the Professor of Mineralogy (Prof. Maskelyne) on Crystallography	-	-	-	6 or 7

26060.

Attending the lectures of the Professor of Geology (Prof. Phillips):

October 1869, twelve lectures:

Gentlemen	-	-	-	-	56
Ladies	-	-	-	-	30

Easter and Trinity Term, 1870, twelve lectures:

Gentlemen	-	-	-	-	29
Ladies	-	-	-	-	20

Attending the lectures of the Linacre Professor of Physiology (Prof. Rolleston):

Three terms—Oct. 1869, Hilary 1870, and Easter 1870

56

Attending the lectures of the Hope Professor of Zoology (Mr. Westwood)

none.

[The Hope Professor states, that although due notice was issued in the *Oxford University Gazette* of his intention to give lectures, he was unable to form a class, and consequently no lectures were given. Several undergraduates availed themselves, however, of consulting the Professor privately; and, in conjunction with the Professor of Botany, a series of scientific excursions in the neighbourhood of Oxford took place during the Summer Term, which 12 students attended.]

#### COLLEGES.

##### University.

Attending natural science classes - - - 1  
[This student obtained a place in the first class at the public examination in natural science in the Trinity Term, 1870.]

##### Balliol.

[No information received.]

##### Merton.

[See pp. 10 and 34.]

##### Exeter.

Students attending science classes - - - 8  
[No special classes for the teaching of science are assembled in Exeter College.]

##### Oriel.

Junior members of the College attending science classes - - - 2

##### Queen's.

Students attending science classes - - - 6  
[Three in science and three in mixed mathematics.]

##### New.

[No information received.]

##### Lincoln.

[No information received.]

##### All Souls'.

[No information received.]

##### Magdalen.

Attending the lectures given in Magdalen College laboratory by Mr. Edward Chapman, Tutor in Physical Science to the College:  
Michaelmas Term 1869 - - - 17  
Lent Term and Easter Term 1870 - - - 24

##### Brasenose.

No lectures in physical science given. The members of the College who study science attend the lectures at the University Museum.

##### Corpus Christi.

Attending classes in which science was taught - 6



**Christ Church.**

Attending the lectures of the Chemical Reader (Mr. Harcourt) - - - - 16

Working in laboratory - - - - 9

Attending the lectures of the Physical Reader (Mr. Reinold):

In the Lent Term - - - - 16

In the Summer Term - - - - 30

Ten of these were from Wadham, Merton, and Magdalen Colleges; one was an unattached student, twelve were Christ Church men, and the remainder were members of other Colleges in Oxford.

Attending the lectures of the Physiological Reader (Mr. Thompson):

In the October Term - - - - 10

In the Easter Term - - - - 8

In the Summer Term - - - - 12

**Trinity.**

Students of the College attending University science classes in which science, other than pure and mixed mathematics and moral science, was taught 3

**St. John's.**

[No information received.]

**Jesus.**

[No information received.]

**Wadham.**

[No information received.]

**Pembroke.**

Attending science classes - - - - 2

**Worcester.**

No students of the College at present attending classes for scientific instruction (exclusive of pure mathematics), nor have been during the past year.

**HALLS.****St. Mary.**

[No information received.]

**Magdalen.**

Students attending science classes - - - - 3

[It is not in the power of the Principal of Magdalen Hall to say how many more may have attended lectures on geology and other branches of science, more or less popular, for general improvement or other objects.]

**New Inn.**

[No information received.]

**St. Alban.**

[No information received.]

**St. Edmund Hall.**

No students attended science classes.

The following additional information has also been received from Oxford on the subject.

**OXFORD UNIVERSITY LABORATORY.**

REPORT on the Number of Students working in the University Laboratory from May 1868 to July 1870.

Term.	Year.	No. of Students.
Michaelmas -	1868	16
Hilary -	1869	21
Easter -	1869	19
Michaelmas -	1869	23
Hilary -	1870	24
Easter -	1870	22

In Easter Term of 1869, the laboratory system of instruction was arranged as in the printed paper affixed.\* The

\* LABORATORY INSTRUCTION, MICHAELMAS TERM, 1869.—The fee for students working in the laboratory for three days in the week during the term is 3*l.* 10*s.*, for students working every day 5*l.*

This fee includes the use of all apparatus and reagents essential to the student, with the exception of a small amount of apparatus peculiarly liable to be broken. The ordinary course of instruction in the laboratory includes those methods of *qualitative* analysis, a knowledge of which is required for these candidates for honours in the school of natural science who make chemistry their special subject.

In addition to this, two courses of instruction will be given in the laboratory, the one on the methods of *quantitative* analysis, on Mondays, Wednesdays, and Fridays, at 10 o'clock, by the Demonstrator in Chemistry, Mr. Heathcote Wyndham, M.A.; the other a course of elementary practical instruction in chemical manipulation.

The fee for each of these classes will be, to students otherwise working in the laboratory, 10*s.*, to others 1*l.*

The following text-books are recommended:—

For *quantitative* analysis—Fresenius' "Quantitative Analysis;" Grenville Williams' "Chemical Manipulation."

For general *qualitative* analysis—Fresenius' "Qualitative Analysis."

For *quantitative* analysis of simple salts and elementary chemical manipulation—Harcourt and Madan's "Exercises in Practical Chemistry."

University Museum, October 21, 1869.

system of instruction provides for the teaching of students coming to the University with various amounts of knowledge of practical analysis. If the student is commencing the study of chemistry, and has not practically acquired the knowledge to be gained in such a class, he is placed for one Term in the "Elementary Practical Class," where he makes, under the eye of the instructor, the simpler form of apparatus required in the laboratory, and also prepares practically the gaseous compounds which are more frequently met with. During this term he does not work in the students' laboratory.

Elementary practical class.

The student who has passed this class, or who is already, on entering the University, practically acquainted with this work, enters the laboratory, and, under the eye of the Professor and Demonstrator, works by himself at the properties of the simpler bases and acids, till he can determine with facility the composition of a substance containing only a single acid and a single base. After this, he works out practically the processes by which the bases and acids are detected in the presence of other bases and acids, and by which the elements hydrogen, nitrogen, and carbon are detected in organic compounds. As soon as he is acquainted with these methods, he enters the "Advanced Practical Class," in which he performs certain selected experimental methods of quantitative research under the eye of the Demonstrator. The method of work having been previously explained to him, and, on the days on which he is not working in the practical class, works at a selected series of quantitative determinations under the care of the Professor and Demonstrator.

Course of instruction in the laboratory.

Advanced practical class.

The advanced practical class is so arranged as to include in successive Terms methods of quantitative research selected from—

A. Method of general use in quantitative analysis.

B. " of volumetric analysis.

C. " of gravimetric.

D. " of organic.

E. " for analysis, determinations of vapour densities.

1870.

**MERTON COLLEGE, OXFORD.****REPORT on the ENCOURAGEMENT given to NATURAL SCIENCE by the College.**

Out of 24 *Fellowships*, the College has given one Fellowship, after an examination in natural science only. The Fellow then elected is resident, and has charge of the natural science instruction in the College.

Fellowship given for natural science.

The average number of *Scholarships* vacant in each year is three. Of these, the first is devoted to classics, the second to mathematics, the third to natural science, so that, with few exceptions, a natural science scholarship will be given every year. The value of the scholarship is 80*l.* per annum for five years.

Scholarships in natural science.

In addition to the scholarships, three *exhibitions*\* of the value of 25*l.* per annum for three years are annually vacant. These are distributed amongst the candidates in the three subjects, according to the comparative excellence of the candidates.

Exhibition in natural science.

The number of natural science scholars already elected is three. In the scholarship examination of 1867, 16 candidates presented themselves; in the examination of 1868 15 candidates. In 1869 there was no election, owing to a change in the time of examination. A natural science scholarship will be given in 1870, on December 7th. A notice of the scholarship is appended.\*

Number of scholars elected at present time and number of candidates at scholarship examinations.

The natural science instruction given in the College is in chemistry, partly by lectures, partly by individual teaching. The Lecturer gives lectures and instruction in chemistry only, but by a private arrangement with the Lecturer in Physiology in Magdalen College, and the Lecturer in Physics at Wadham College, of the nature of the exchange of pupils, he provides instruction in these subjects also.

Instruction in natural science in the college. Nature of the instruction.

The College has fitted up a lecture room for natural science and mathematics, in such a way that the students

Natural science work and reading.

\* NATURAL SCIENCE SCHOLARSHIP AND EXHIBITIONS.—At the annual election on December 7, a scholarship of the value of 80*l.* per annum for five years will be given after an examination in natural science.

One or more exhibitions, of the value of 25*l.* per annum for three years, will also be given, provided that candidates of sufficient merit present themselves.

Papers will be set in chemistry, physics, and physiology; and an opportunity will be given of showing a knowledge of practical work in chemistry and physiology.

The scholarship and exhibitions will be given either for special excellence in one subject, or for excellence in two of the three subjects; but no candidate will be examined in more than two subjects.

There is no limit of age for the candidates, but a limit of six Terms of University standing.

The examination will commence on Friday, December 2, at 9 a.m., in Merton College Hall. Candidates are required to call on the Warden on Thursday, December 1, between 4.30 and 5.30 p.m. October 12, 1870.



can make use of it as a *reading room* and *work room*, when not required for lectures. It is lighted and warmed in the evenings as well as in the daytime, and a microscope and certain pieces of apparatus have been provided, as well as a small *library of scientific books and periodicals*.

## MAGDALEN COLLEGE, OXFORD.

Magdalen College, Laboratory,  
DEAR MR. PRESIDENT, Nov. 2, 1870.

IN forwarding my report of the number of students who have attended my lectures during the session 1869–1870, I think it might materially aid the inquiries of the Royal Commissioners if I gave a short account of the machinery now at work for the teaching of Physical Science in Magdalen College.

The College laboratory is a block of buildings containing a number of rooms exclusively devoted to science. On the ground floor is the laboratory proper, a large lecture room fitted up with the ordinary appliances for chemical demonstration, and containing also a quantity of physical and chemical apparatus. Adjoining this is a private room used by your tutor, containing the more valuable instruments, and also the geological collection of the late Professor Daubeny. Over this is a similar room containing a collection of minerals, which, together with the geological collection below, are well catalogued and arranged. In a room on the ground floor I have placed all the instruments connected with meteorology, the examples of barometers and thermometers being numerous and varied. Above this room is placed an achromatic telescope, with a 5½-inch object glass, equatorially mounted, and with tangent screw motions.

A large upper room has been fitted up as a reading room for students, and is supplied with several scientific periodicals; it is much used also as a convenient place for the examination and working up of specimens by the pupil after a demonstration by the teacher. I am here forming a collection of specimens to illustrate comparative osteology.

This room, and in fact the whole laboratory, is accessible to students at all reasonable hours.

The method of teaching I have adopted has been—

- (1.) A course of advanced lectures intended for candidates for honours in the Physical Science School. These lectures combine formal teaching in a class with attention to the individual requirements of each candidate in private.
- (2.) A course of lectures on elementary chemical physics, intended for beginners. These lectures are not given with the view of training men necessarily for the physical science school, but as a means of general education, in the hope that an intelligent interest may be excited in the mind of the student, and habits of observation and accuracy established.

With this view I have instituted a series of meteorological records. The daily observations include corrected and reduced readings from a standard barometer, readings of the maximum and minimum temperature—the wet and dry bulb thermometers—maximum solar radiation, direction and speed of wind, and the rainfall.

These observations are duly registered, and I believe have not been without use to my pupils.

In conclusion, I must add that it has always been my aim to supplement the work of our professors by taking care that each student in physical science shall receive the same help and attention from his College Tutor as that enjoyed by the classical or mathematical candidate. I am the more confirmed in this view, as I have found that such a system often reaches men who, but for the fact that the subject was brought to them in college, would never have taken up the study at all.

Considerable experience in tuition has convinced me that physical science as an instrument of education will flourish the better in Oxford the more it becomes an integral part of our College System.

I append the list of undergraduate members of Magdalen College who have attended my lectures during the session 1869–1870. The figures show the actual number attending. The number on my register for Easter Term 1870 is 16, but of these, 3 did not attend (by arrangement), owing to the pressure of University examinations. I may add that the number attending was 3 in Lent Term 1869, and 4 in Easter Term 1869.

I remain, dear Mr. President,

Yours very truly,

EDWARD CHAPMAN, M.A.,

Tutor in Physical Science at Magdalen College,  
and Public Examiner in the School of  
Physical Science.

## Return of the Number of Students attending Lectures from October 1869 to June 1870.

	Mich. Term, 1869.	Lent Term, 1870.	Easter Term, 1870.
Students being Undergraduate members of Magdalen College.	9	14	13

N.B.—The total number of resident undergraduates in the College during the same period was:

	Mich. Term, 1869.	Lent Term, 1870.	Easter Term, 1870.
Total number of Undergraduate residents in Magdalen College.	55	50	55

Examined and found correct.

FREDERIC BULLEY,  
President.

Magdalen College,  
November 5, 1870.

## CAMBRIDGE.

## UNIVERSITY.

Attending the lectures of the Regius Professor of Physics (Dr. Bond) -	16
Attending the lectures of the Lucasian Professor of Mathematics (Prof. Stokes) -	33
Attending the lectures of the Professor of Chemistry (Prof. Liveing) on Chemistry -	52
Attending the practical class -	24
Attending Prof. Liveing's lectures on Physics -	65
Attending the lectures of the Professor of Astronomy and Experimental Philosophy (Prof. Challis) -	9
[This is the number attending at one time; the number attending in one year has seldom exceeded twenty. Professor Challis says, "I ought, perhaps, to explain that my astronomical lectures are mainly adapted to the class of students who are candidates for the higher mathematical honours."]	
Attending the lectures of the Professor of Anatomy (Prof. Humphry) -	42
Attending the lectures of the Professor of Botany (Prof. Babington) -	61
Attending the lectures of the Woodwardian Professor of Geology (Prof. Sedgwick) -	35
Attending the lectures of the Professor of Astronomy and Geometry (Prof. Adams) -	4
Attending the lectures of the Professor of Natural and Experimental Philosophy (Prof. Willis) -	17
Attending the lectures of the Downing Professor of Medicine (Prof. Webster Fisher, Dr. Latham acting as his deputy) -	11
Attending the lectures of the Professor of Mineralogy (Prof. Miller) -	7 or 8
Attending the lectures of the Professor of Zoology and Comparative Anatomy (Prof. Newton) -	-

[Professor Newton makes the following statement:

"The only record I have of the number of students attending my lectures is a list of those who write their names on a board at the lecture room door, and, should they be students of medicine requiring a certificate of diligent attendance, leave their card with me at the end of the lecture. Of the former there were, in the Michaelmas Term, 1869, 22, and in the Lent Term, 1870, 18. Of the latter, the largest and smallest number present on any one day was, in the Michaelmas Term, 16 and 6 respectively, and in the Lent Term 13 and 8. During the present Term, 26 persons have inscribed their names on my board, while the largest number of cards has been 22, and the smallest 11. Others, as well members of the University as strangers, attend, and their number is occasionally not inconsiderable, but I have no means of making any estimate on the subject.—Alfred Newton, Cambridge, 2nd December 1870."]



## COLLEGES.

*St. Peter's.*  
Students attending science classes - - - 12

*Clare.*  
[The Master of Clare states: "If I understand the sense in which the term 'science' is used in the circular, there have been no classes of science held in this College during the year 1869-70."]

*Penbroke.*  
Students attending lectures on applied mathematics and natural philosophy (candidates for honours in the Mathematical Tripos) - - 14  
Students attending lectures on botany, zoology, anatomy, chemistry, and medicine (candidates for Natural Sciences Tripos and for medical degrees) - 2  
Student attending lectures on geology - 1  
Students attending lectures on elementary mechanics and hydrostatics, for ordinary degree - 12

*Gonville and Caius.*  
Number of students, members of Caius College, who have attended lectures on science.

*Michaelmas Term, 1869:*  
Chemistry - - - 6 } 12  
Anatomy and physiology - - - 6 }

*Lent Term, 1870:*  
Anatomy and physiology - - - 5

*Easter Term, 1870:*  
Anatomy and physiology - - - 5  
Six other students attended two courses each of University lectures on anatomy, chemistry, botany, and geology - - - 6

Students of both Gonville and Caius College and Clare College attending mathematical lectures.

Gonville and Caius. Clare.

*Michaelmas Term, 1869:*  
Rigid dynamics - - - 1 3 = 4  
Mechanics - - - 12 2 = 14

*Lent Term, 1870:*  
Statics - - - 7 6 = 13  
Mechanics - - - 7 1 = 8

*Easter Term, 1870:*  
Dynamics and Newton - 4 3 = 7  
Astronomy - - - 3 3 = 6

*Long Vacation, 1870:*  
Rigid dynamics - - - 1 3 = 4

*Trinity Hall.*

Students attending lectures in Michaelmas Term, 1869 - - - 45  
(Students in residence, 100.)

Students attending lectures in Lent Term, 1870 - 46  
(Students in residence, 85.)

Students attending lectures in Easter Term, 1870 - 36  
(Students in residence, 78.)

*Corpus Christi College.*

[No information received.]

*King's.*

[See p. 46.]

*Queen's.*

Students attending lectures in natural philosophy - 11  
In natural sciences - - - 3

*St. Catharine's.*

Students attending science classes - - - 2

*Jesus.*

[No information received.]

*Christ's.*

[There is at present no direct instruction given in this College in natural and applied science.]

*St. John's.*

[No information received from *St. John's*, but see below under *Trinity College*.]

*Magdalene.*

Students attending classes in which science is taught - - - 9

*Trinity.*

Lectures on science, 1869-1870.

The numbers attached signify the number of students attending.

*Michaelmas Term, 1869.*

Optics and hydrostatics (higher class) - - - 9  
Elementary optics - - - 19  
Elementary mechanics (for ordinary B.A. degree: two classes) - - - 30  
\*Electricity and heat - - - 6  
\*Botany - - - 4

*Lent Term, 1870.*

Newton's Principia - - - 12  
Elementary mechanics and hydrostatics (three classes) - - - 36  
Hydrostatics (higher class) - - - 16  
\*Electricity (elementary) - - - 7  
\*Do. (advanced) - - - 8

*Easter Term, 1870.*

Honour classes. { Rigid dynamics - - - 8  
Astronomy - - - 17  
Statics and dynamics - - - 15  
Elementary dynamics - - - 16  
Mechanics and hydrostatics (for ordinary B.A. degree: three classes) - - - 29  
\*Heat (elementary) - - - 5  
\*Do. (advanced) - - - 6

\*By an arrangement with *St. John's College*, members of that College are admitted to these lectures, and members of *Trinity College* are admitted to the lectures on natural science at *St. John's*.

In addition to the above regular courses of lectures, occasional lectures are given on various subjects, according to the taste of the lecturer, of which no record is kept.

E. W. BLORE,  
Senior Tutor.

*Emmanuel.*

Students devoting their attention exclusively to natural science - - - 2

[No record has been kept of the students of the College who have attended various University lectures on science.]

*Sidney Sussex.*

Students attending science classes:

Lectures on heat - - - 5 }  
" on geology - - - 2 }  
" on mineralogy - - - 1 }  
" on physiology - - - 2 } 15  
" on botany - - - 2 }  
" on natural science in College laboratory - - - 3 }

[The College laboratory is open to all the students, and used by many. All the students attend lectures in College on applied as well as on pure mathematics.]

*Downing.*

Students who attended natural science lectures - 4

## DURHAM.

*University.*

[No information received.]

## LONDON.

## UNIVERSITY COLLEGE.

Return of the Number of Students attending the under-mentioned Science Classes in the College, during the Session of 1869-70.

Architecture - - - 28  
Chemistry (theoretical) - - - 140  
" (practical) - - - 132  
" (analytical) - - - 22  
Botany - - - 101  
Comparative anatomy and zoology - - - 21  
Engineering and mechanical drawing - - - 8  
Geology and mineralogy - - - 44  
Logic and mental philosophy - - - 28  
Mathematics and mechanics (applied) - - - 27  
Physics (= "Natural philosophy") - - - 90  
Physical laboratory - - - 9  
Physiology (theoretical) - - - 164  
Physiology (practical) and histology - - - 52  
Political economy - - - 15

JOHN ROBSON, B.A.,  
Secretary to the Council.

Nov. 21st, 1870.

## KING'S COLLEGE.

Number of matriculated students (attending the whole course of instruction) - - - 66

Number of occasional students—

in chemistry - - - 6 }  
in practical chemistry - - - 0 }  
in physical laboratory - - - 10 }  
in arts of construction - - - 5 }  
in manufacturing art - - - 3 }  
in mineralogy and geology - - - 3 } 40  
in photography - - - 1 }  
in mechanics (lectures) - - - 2 }  
in workshop - - - 8 }  
in drawing - - - 2 }



These numbers are taken for the Lent Term, 1870. The number of matriculated students was then the largest; but it may easily have happened that the number of occasional students in various classes may have been greater at other periods.

ALFRED BARRY, D.D.,  
August 17th, 1870. Principal.

## ROYAL SCHOOL OF MINES.

[No answer received; but see the evidence of Mr. Trenham Reeks, Qu. 372, p. 26.]

## MANCHESTER.

## OWENS COLLEGE.

Return of the Number of Students attending the several classes in which Science was taught in the Session 1869-70.

## I.—DAY CLASSES.

	No. of Students.
1. Natural Philosophy.	
A. Experimental Classes:	
a. Mechanics: statics, dynamics, hydrostatics, and optics	81
b. Physics: light, heat, and sound	27
B. Mathematical Classes.	
a. Junior: elementary statics, dynamics, hydrostatics, and geometrical optics	11
b. Senior: statics and dynamics of a particle, rigid dynamics, hydrostatics and dynamics, physical optics	2
2. Chemistry.	
A. Lecture Classes	
a. Junior: inorganic	105
b. Senior: inorganic and organic	19
c. Analytical chemistry	15
d. Technology	9
B. Laboratory Classes	51
3. Engineering.	
a. Mechanical engineering	12
b. Civil do.	8
c. Senior class (mechanical and civil)	2
d. Geometrical and mechanical drawing	16
4. Natural History.	
a. Animal physiology and zoology	9
b. Geology	12
c. Botany	5

## II.—EVENING CLASSES.

1. Natural Philosophy:	
Experimental physics	18
2. Chemistry.	
A. Lecture Classes:	
a. First course: non-metallic elements	63
b. Second course: the metals	18
c. Third course: organic	6
B. Laboratory	10
3. Engineering, mechanical and civil:	
a. Junior class	24
b. Senior class	12
c. Geometrical and mechanical drawing	5
4. Natural History:	
a. Zoology	5
b. Geology	14
c. Botany	21
d. Pharmaceutical botany	28

J. G. GREENWOOD,  
Principal.

18th August 1870.

## SCOTLAND.

## ST. ANDREW'S.

## UNIVERSITY.

Students attending classes in natural philosophy	33
"    "    " in chemistry	19
"    "    " in physiology and hygiene	42

## ABERDEEN.

## UNIVERSITY.

Students attending classes in—	
1. Natural philosophy	90
2. Natural history (winter), zoology, with comparative anatomy	71
Ditto ditto (summer)	41

3. Anatomy (winter), attending lectures on practical anatomy, or both	125	} 221
Ditto (summer), attending general anatomy or osteology	96	
4. Physiology		38
5. Chemistry, theoretical	96	} 158
Ditto practical (summer)	62	
6. Botany, only in summer		77
7. Materia medica		53

P. C. CAMPBELL, D.D.,  
Principal.

University of Aberdeen,  
17th August 1870.

[The Principal adds in a postscript, "I presume that the students attending the class of logic, in which mental physiology is taught, are not intended to be included, as the moral philosophy class, in which that subject is also taught in some of its aspects, is excluded. The number attending the logic class was about 70."]

## GLASGOW.

## UNIVERSITY.

[On making a second application for the desired return, the Clerk of the Senate replied on the 9th of December 1870, "I am instructed to inform you that the Senate have no other means of making up such a return except from the *Class Catalogues*, which I sent you in August last." It was not possible, however, for the Commission to make out from the *Class Catalogues* an accurate return of the number of the students attending the science classes at any one time, as a "notice" at the beginning of the *Catalogues* states that "in the following printed *Catalogues* the occurrence of a name merely indicates that such a student was enrolled in the class in which the name is found, but affords no evidence of his having attended even for a day. This can be ascertained only from the Professor's certificate."]

## EDINBURGH.

## UNIVERSITY.

Returns of the Number of Students attending classes in which science was taught during the session 1869-70.

Note.—Attendance at the classes of botany, natural history, and chemistry, is required for graduation in medicine.

1. Natural philosophy	185
2. Applied mathematics	3
3. Physical laboratory	20
4. Practical astronomy	1
5. Agriculture	27
6. Music { Division 1 (under "H"), about	50
Do. 2 do.	8
7. Engineering	26
8. Mechanical drawing	9
9. Surveying and levelling	12
10. Chemistry	232
11. Practical chemistry	135
12. Chemical laboratory	15
13. Systematic physiology	127
14. Practical physiology	89
15. Lectures on anatomy	240
16. Anatomical demonstrations	159
17. Practical anatomy { Winter course	264
Summer course	97
18. } Natural history and mineralogy	[No return.]
19. }	
20. Geology	283
21. Botanical class	38
22. Vegetable histology class	124
23. }	
24. }	
25. { Winter session, practice of medicine	64
Summer session, medical psychology and mental diseases	31
26. Surgery	110
27. Bandaging class	110
28. Operative surgery (summer)	28
29. Midwifery	110
30. { Systematic course of general pathology and morbid anatomy	100
31. }	
32. { Summer course of practical morbid anatomy and pathology	18
33. Clinical medicine, average for summer and winter sessions, about	100
34. Clinical surgery { Winter session	116
Summer session	62
35. Medical jurisprudence	69



## IRELAND.

## DUBLIN.

## UNIVERSITY.

[No information received.]

## QUEEN'S UNIVERSITY IN IRELAND.

1. *Queen's College, Belfast.*

Return of the Number of Students attending any classes in which science was taught during the session 1869-1870. Not including pure mathematics.

—	Number in Class.	Number taking Science.
Arts, 4th year - -	10	5
„ 3rd „ - -	36	23
„ 2nd „ - -	38	38
„ 1st „ - -	43	—
Engineering - -	23	23
Law - -	23	—
Various - -	14	9
Medical :		
Matriculated - -	145	96
Non-matriculated - -	22	13
Various :		
Non-matriculated - -	n	6
	360	213
In two departments - -	7	
Number at College - -	353	

N.B.—Arts men of 1st year all take pure mathematics. All medical students take science classes at some period of their course.

(Signed) RD. OULTON,  
Registrar.

2. *Queen's College, Cork.*

A Return of the Number of Students attending classes in Queen's College, Cork, in which science was taught, excepting pure mathematics or moral science, during session 1869-70.

	Number of Students.
Chemistry - - - -	69
Practical chemistry - - - -	48
Natural history - - - -	56
Natural philosophy - - - -	78
Political economy - - - -	6
Geology and mineralogy - - - -	15

ROBERT J. KENNY,  
Registrar, Queen's College, Cork.

In addition to the above, there were attending the engineering classes, during session 1869-70, 36 students.

ROBERT J. KENNY,  
Registrar.

Approved,  
ROBERT KANE,  
President.

16th August 1870.

3. *Queen's College, Galway.*

[No information received.]

## APPENDIX X. (See Question 5936.)

FORM used by the INSPECTOR OF SCIENCE SCHOOLS conducted under the SCIENCE AND ART DEPARTMENT.

Science and Art Form No. 337.

South Kensington, Oct. 1870.

SCIENCE AND ART DEPARTMENT of the Committee of Council on Education, South Kensington.

Inspector's Report on the science and art classes, established at [Name of Institution]

taught by [Name of Town]

[Names of Teachers and their Qualifications.]

Visited on the 187 [Signature of the Inspector.]

NOTE.—The Inspector is requested to answer the questions in this report as briefly as possible. Any more lengthy observations or recommendations he may feel called on to make, he should insert after "Remarks" under each head.

## I.—COMMITTEE.

1. Are the chairman, secretary, and members of the committee respectively qualified according to the requirements of the Department?

2. Are they properly acquainted with the duties which they have to perform?

3. As far as you can judge, do you consider them sufficiently intelligent and responsible to ensure the examination being honestly conducted according to the rules of the Department?

4. Endeavour to ascertain and report whether the committee as a body take any active interest in the welfare of the classes; or whether the management be left in the hands of a few, or of the teacher alone?

5. How many members of the committee were present on the occasion of your visit?

REMARKS:—

## II.—SCHOOL PREMISES.

1. Are the class rooms convenient and well suited, in point of size and accommodation, for the instruction given in them? And are they well lighted, heated, and ventilated?

2. Is the institution in which the classes are held endowed? Or is there any subscription or contribution on the part of the locality in aid of the science instruction?

3. On what terms, and under what conditions, are the teachers allowed to use the rooms for instruction?

REMARKS:—

## III.—EXAMINATION.

1. Is the room or building in which the examination is to be held convenient as regards size and accommodation?

2. Are any other classes held within a convenient distance?

N.B.—If this question is answered in the affirmative, state under the head of "Remarks" below the reason for or against an amalgamation according to the rules of the Science Directory, and add a recommendation of your own on the subject.

REMARKS:—

## IV.—REGISTERS.

## A.—General Register.

1. Are the entries in this register properly made?

2. Is it kept by the secretary or a member of the committee? If not, by whom?

3. Give the number of middle-class students (if any), that is, students on whom, owing to their social position, no claim can be made.

4. What fees are paid by the students?

5. Are the meetings of the committee entered on the eighth page of the form? Or is there any means of recording visits of the members of the committee to the class?

## B.—Class Registers of Attendance.

1. Are these registers properly kept?

2. Does a properly qualified teacher attend every meeting of the class?

3. State the subjects in which lessons were given on the occasion of your visit, and the number of pupils present.

4. Has the attendance of pupils fallen off or increased since the commencement of the classes?

REMARKS:—



## V.—INSTRUCTION.

1. Do you consider the instruction in science to be efficiently given?
2. Do the pupils show signs of having been crammed or of learning by heart?
3. Is the apparatus sufficient in quantity and quality to properly illustrate the teaching of science?

REMARKS:—

## VI.—APPARATUS.

1. Have any examples or apparatus been supplied by aid from the Department? If so, of what kind?
2. Are there presses or other proper places for keeping them when not in use?
3. Are they kept clean and in good order?

REMARKS:—

## APPENDIX XI. (See Question 6188.)

## MEMORANDUM on the Progress of Scientific Instruction in Yorkshire, by Henry H. Sales.

The Paris Exhibition of 1867 aroused the attention of Yorkshire manufacturers to the importance of scientific instruction. A special meeting of the Central Committee of the Yorkshire Union of Mechanics' Institutes was held on the 22nd of August, under the chairmanship of Mr. Baines, M.P., President of the Union. This meeting unanimously resolved—

"That the Council of the Yorkshire Union of Mechanics' Institutes, feeling the great importance of encouraging and extending the scientific instruction given in mechanics' institutes, and deeply impressed with the evidence recently published, as to the comparative low state of scientific education in England, authorise Mr. Henry H. Sales to visit the towns of Yorkshire in which scientific instruction is given, in mechanics' institutes or otherwise, and to report the state of that instruction and the opinions of the officers or others as to the best practical means of increasing the efficiency of scientific classes."

The report on the condition of scientific instruction presented to the committee in conformity with this resolution was a very unfavourable one. On the 13th of February 1868, another meeting of the committee was held, and the following resolutions were unanimously adopted—

"That the Report of the Agent of the Union on Technical Education in Yorkshire be laid before the Government."

"That the committee, in submitting this report to the Government, beg to recommend that a Royal Commission or Parliamentary Committee be appointed to make an inquiry into the present state of technical education in this country, and on the continent, with a view of devising such methods for its improvement in England as may render it more commensurate with the wants and conducive to the prosperity of this great manufacturing country."

"That the committee think it their duty to draw the special attention of the Government to the want of properly-trained and qualified teachers of science in this country, and to the consequent inefficiency of the scientific instruction given in mechanics' and other popular institutions and evening classes, which are otherwise capable (with efficient teachers) of rendering the most valuable aid to practical science."

"That the committee would also express their belief that Technical Colleges or Schools of a superior kind, might with the greatest advantage be established in the principal centres of manufacturing industry in the United Kingdom."

No immediate steps having been taken by the Government to provide a supply of properly-trained and qualified teachers of science, and it being impossible for the Yorkshire Union of Mechanics' Institutes to organise classes without such teachers, the central committee directed the attention of the Council of the Yorkshire Board of Education to the difficulty in which they were placed, and asked for the co-operation of that Board. The council immediately took action, and a series of public meetings for schoolmasters was convened by the council, to induce them to qualify themselves, in accordance with the requirements of the Government, to give instruction in science. The first meeting was held in Leeds under the presidency of Sir Andrew Fairbairn, mayor. At Stockton the chair was taken by Mr. Whitwell. The Rev. Canon Sale, D.D., Vicar of Sheffield, presided over a meeting in that town; and at Huddersfield and Wakefield, the mayors of the respective towns occupied the chair. In addition to the members of the Council of the Yorkshire Board of Education, many of the principal manufacturers and educationists took part in the proceedings. But the Board did more than hold meetings. Special science classes for schoolmasters were organised at Leeds, Sheffield, Wakefield, and

Huddersfield, of which upwards of 100 schoolmasters became members. In the following autumn the mayors of Bradford and Halifax presided over similar meetings in those towns, and classes were also established. The work of the Board in this movement has been singularly successful, and, so far as the teaching of the rudiments of science is concerned, there is now in Yorkshire a fair supply of duly-qualified teachers. So important was the action taken by the Board considered to be, that it formed the subject of a leading commendatory article in the "Times," on the 9th of November 1868.

A supply of teachers having been provided, the extension of the science classes in connexion with the Government was proceeded with by the Yorkshire Board of Education.

The number of science schools in Yorkshire, actually fulfilling the requirements of the Government, at the close of the last official year was 84, and the number of students 2,389, a marked contrast to the results for the year 1868, when the numbers were: schools 14, students 426. But the contrast is in still stronger relief when the numerical details are considered. In Bradford, in 1866, there were no science schools; in 1870, there were seven with 185 students. In Huddersfield, in 1866, there was one school with 26 students; in 1870, seven schools and 230 students. In Leeds, 1866, there was one school with 33 students; in 1870, eight schools and 465 students. In Hull, in 1866, omitting the special navigation school, no classes existed; in 1870, two classes and 74 students. Sheffield had no classes in 1866, but eight in 1870, and 257 students. Wakefield, likewise, had no classes in 1866, but three classes and 105 students in 1870.

But the extension of the system of Government science schools revealed a new unoccupied field of necessary work. To maintain a science constituency, competent to profit by instruction in the higher branches of science necessary for the maintenance of our manufacturing prosperity, the alphabet of science must be learned during the period of ordinary school life. Insurmountable difficulties are in the way of teachers who have to commence the scientific instruction of young men destitute of all scientific knowledge, and yet, if such students are to earn Government results for the remuneration of the teacher, they must, in a very limited period, be prepared to pass a severe examination. Again, at the request of the Yorkshire Union of Mechanics' Institutes, the council of the Yorkshire Board of Education took steps to remove this evil. At Wakefield and Sheffield classes, under Mr. Patchet and Dr. Harrison, were formed for giving instruction in the rudiments of science to school-boys.

For 30 weeks, the elder boys of the primary schools in Sheffield were assembled on one evening in each week, for the purpose of receiving instruction in the rudiments of inorganic chemistry. The object the council desired to accomplish was, to awaken in the boys an interest in the subject which, in so many cases, will enter into their future labour, and thereby to create a desire for fuller acquaintance with it, thus substituting for the "rule of thumb," an intelligent knowledge of the principles of their work. 112 boys formed the class. Measured by the examination of the Department of Science and Art, the amount of knowledge gained was considerable, for no less than 26 passed in the annual May examinations of the Department. But the testimony of the parents, shown in their great interest for the advancement of their children, is far more conclusive respecting the value of the class. And still more important is the evidence of the schoolmasters, who have unanimously expressed their opinion that the class-lessons have developed the intelligence of the pupils, and created in them a love for instruction in the rudiments of science.

It is now unnecessary for the committee to continue these classes, for three reasons: Firstly, the Sheffield class



is a sufficient proof that children can be taught some branch of science; secondly, classes for school boys are now being extensively organised throughout the country; and thirdly, the introduction of scientific instruction into primary schools, so persistently advocated by this Board, has been effected by the Right Hon. W. E. Forster, M.P., Vice-President of the Committee of Council for Education, who has directed that a special grant be made to the managers of State-aided schools for each scholar who passes a satisfactory examination in some definite branch of natural science.

In advance of the instruction in science now provided for in the elementary State-aided schools is the more advanced instruction in trade schools. No system can provide for our countrymen the like amount of education as is given in continental institutions, if early instruction in science be neglected. It is to the establishment of trade schools that we must look for the source of our advancement in technical knowledge. It is now understood that a trade school is an institution that will provide for the education of the sons of skilled workmen, managers of factories, and manufacturers, who are able to pay a fee that, with the aid from the Science and Art Department, will make the school self-supporting. The education therein given includes all the branches of an ordinary English education, but adds thereto special instruction in science and art, more particularly bearing on the trade of the district. The establishment of such schools has for some time engaged the attention of the Yorkshire Board of Education, and two years since the executive submitted to the Committee of the Keighley Institution plans for the organisation of a trade school in the building then in course of erection. The suggestions made by Mr. Sales, though unexpected, were well received, and have ultimately been adopted. At that time the Endowed Schools' Commissioners had not commenced the reform of the grammar schools, but the passing of the Act and the consequent re-organisation of the Yorkshire grammar schools has produced unlooked for beneficial results in the furtherance of scientific instruction generally, and, in the case of Keighley, in placing upon a permanent basis its trade school. The grammar school was established in 1713. Its independent re-organisation, as a second grade modern school, would have seriously militated against the progress of the trade school, but negotiations having been opened between the building Committee and the Commissioners, the latter having propounded a scheme whereby the grammar school will be reconstituted as a girls' school, and a portion of the endowment, which will eventually reach the sum of 200*l.*, be transferred to the managers of the trade school. By this scheme, the important subject of female education is satisfactorily dealt with, and, at the same time, provision is made for technical education. The importance of the trade school cannot be overrated. It will form the constituency of the advanced classes in the schools of art and science, and herein is its great value. Art and science masters bitterly complain of the raw material placed in their hands for evening tuition, but pupils from the trade school will have been already prepared by those masters, and, after a life of labour has commenced, they will be able to carry on, and not commence, their special education in the schools of art and science. The trade school will, therefore, be a component and indispensable part of a comprehensive system of technical education for Keighley.

The operations before detailed refer to the means adopted to promote the scientific instruction of the rising generation.

It is not to be expected that adult workmen, now engaged in daily labour, will very generally devote their evening leisure to attendance upon scientific classes, yet it is expedient that assistance should be given to these men to enable them to gain some knowledge concerning the scientific principles involved in their work. A conference of the trade societies of Leeds and its neighbourhood, summoned by the Executive Committee, was held at the Mechanics' Institute, on February 12th, and was numerously attended by delegates, when it was proposed to arrange for a course of six lectures on science, as applied to the industrial arts. Application was then made to the Science Department for the services of one or more of the gentlemen who are engaged to deliver similar lectures at the School of Mines, London, but the only reply received was to the effect that State aid could not be given to the provinces for such lectures. This anomalous position requires rectification. Lectures on mining and mineralogy are given by eminent professors, engaged by the Government, to a London audience largely composed of clerks and non-artisans, but in the mineral districts, where labour the workers in coal and iron, it is not thought desirable to send suitable instructors at the expense of the State. The Committee having been refused the aid of the Department were thrown upon their own

resources, and agreed to provide lectures, if the trade societies collected an audience. The lecture-room was lent by the Committee of the Leeds Mechanics' Institute. An admission fee of 6*d.* was charged for the whole course of lectures. 280 tickets were sold, and the attention and interest manifested by the audience were most satisfactory. The following was the syllabus:—

*Tuesday, March 8th; Tuesday, March 15th.*

Two Lectures on the Formation and Consumption of Coal, by Mr. Louis C. Miall, Curator of the Museum of the Bradford Philosophical Society.

#### SYLLABUS:—

Lecture I.—The Origin of Coal—Coal Plants—Structure of a Coal Seam—Microscopic Structure of Coal—The Yorkshire Coalfields.

Lecture II.—Constituents of Coal—Products of burnt Coal—Varieties of Coal—The history of the Introduction of Coal as a Fuel—Coalfields of the World—Fuel, the Source of Power—Probable Duration of British Coal.

*Tuesday, March 22nd; Tuesday, March 29th.*

Two Lectures on the Elements of Mechanics, by Mr. Thomas Hick, B.A., of the University of London, and Certificated Master in Science by the Lords of Her Majesty's Committee of Council on Education.

#### SYLLABUS.

Lecture I.—Force and Matter—Work—Machines: their general action and structure—The simple Mechanical Powers—The Lever—Examples of its Use—Relation of Force employed to Work performed—Mechanical advantage—Force not created—Wheel and Axle—Mode of Action and Mechanical Value.

Lecture II.—Results of First Lecture—Pulleys—Structure and Action—Tension—Different Arrangements—Mechanical Value of each System—The Inclined Plane—Its Use as a Mechanical Agent—The Screw: essentially an Inclined Plane—Mode of Action and Mechanical Advantage—Examples of its Use—Conclusion.

*Tuesday, April 5th; Tuesday, April 12th.*

Two Lectures on Chemistry, by Mr. George Ward, Fellow of the Chemical Society, and Certificated Master in Science by the Lords of Her Majesty's Committee of Council on Education.

#### SYLLABUS:—CHEMICAL ACTION.

Lecture I.—Simple Substances or Elements—Compounds—Modes of Chemical Action—Distinction of Chemical Force from every other Force of Matter—Two different kinds of matter necessary for the Operation of Chemical Force—Change of Properties resulting from Chemical Action—Conditions favourable to Chemical Action—Chemical Force only exerted between fixed Quantities of Matter.

#### WATER.

Lecture II.—Water a Compound of Two Gases—Sixteen Parts by Weight of Oxygen, with Two Parts of Hydrogen: or, Two Volumes of Hydrogen with One Volume of Oxygen, producing Three Volumes of Aqueous Vapour—Oxygen—Preparation—Properties—Its Existence in the Atmosphere in a Free State—Hydrogen—The Lightest Substance known—Properties of Hydrogen—A Combustible Substance—Producing when burnt in Oxygen intense Heat—With Formation of Water—Properties of Water—Its Boiling Point—Its Solvent Action—Pure Water—Rain Water—Spring Water—Impurities in Water—Importance of Pure Water.

The Executive Committee have since received the following resolution, agreed upon at a general meeting of the Leeds and district Trades' Council:—

"That this council tender their heartfelt thanks to the Yorkshire Board of Education for the admirable course of scientific lectures especially provided for the artisans of Leeds. The council will hail with pleasure the opportunity to render any assistance in their power to the Board in their efforts to benefit our class.

EDWARD C. DENTON, President.  
THOMAS ALDERTON, Secretary."

The provision being made for scientific instruction in Yorkshire embraces instruction in the rudiments of science in the elementary schools; the establishment of trade schools in Mechanics' Institutes; the introduction of science as a portion of the curriculum of all the re-organised endowed



schools; the extension of evening science schools; and the delivery of courses of scientific lectures to the manual-labour population. There is yet wanting a central county institution for the promotion of scientific study under the direction of professors of the highest eminence. A special meeting of the General Council of the Yorkshire Board of Education was convened on the 5th of November 1869, to consider the establishment of a "Yorkshire College of Science." The meeting was held in the Town Hall, Leeds, under the presidency of Lord F. Cavendish, M.P., and the following resolutions were unanimously adopted:—

Resolution I.

Moved by Colonel Akroyd, M.P., seconded by Colonel Morrison, M.P.:—

"That, in the opinion of this Council, it is desirable that a College of Science should be established in Yorkshire."

Resolution II.

Moved by Mr. I. Holden, seconded by Mr. Baines, M.P.:—

"That a committee be appointed, with power to add to their number, to investigate, consider, and propose the best means to be adopted for the establishment of a Yorkshire College of Science, in co-operation with the Endowed Schools' Commissioners. The Committee to consist of the following gentlemen:—Lord F. Cavendish, M.P. (President); Colonel Akroyd, M.P.; E. Baines, M.P.; J. Behrens; S. Beaumont, M.P.; T. Brooke; W. B. Denison; T. E. Firth; Sir A. Fairbairn; J. G. Fitch; A. Harris; Dr. Heaton; E. Huth; A. Illingworth, M.P.; I. Holden; J. Kitson, junr.; Sir J. Meek; J. G. Marshall; A. J. Mundella, M.P.; Colonel Morrison, M.P.; F. S. Powell; H. W. Ripley; B. Samuelson, M.P.; T. Salt, junr.; W. S. Stanhope; J. Stansfield; the Mayors of Yorkshire, and the Chairmen of the Yorkshire Chambers of Commerce and Agriculture."

The College Committee have since been engaged in visiting existing Institutions of like nature, and in collecting information, and will shortly issue a special report.

## APPENDIX XII. (See Question 5965.)

### ANALYSIS of TEACHERS of SCIENCE CLASSES in connexion with the SCIENCE and ART DEPARTMENT, 1869-70.

Country.	Employed as Organising Masters.		556 Day School Teachers.				311 not otherwise employed as Teachers.				
			Qualified to teach Science.		Not qualified to teach Science.		Holding Honorary Certificates.	Certificated previous to 1867.	Qualified at the May Examinations.	Certificated in some Subjects previous to 1867. Qualified in other Subjects at the May Examinations.	Those who have other employment.
	Day.	Evening.	Certificated as Elementary School Teachers by Whitehall and Dublin.	Uncertificated.	Certificated as Elementary School Teachers by Whitehall and Dublin.	Uncertificated.					
England, Scotland, and Wales.	—	2	273	90	1	1	72	31	164	23	242
Ireland - -	—	—	156	22	1	—	7	2	12	—	17
Total - -	—	2	429	112	2	1	79	33	176	23	259

J. F. D. DONNELLY, Capt. R.E.,  
Official Inspector.

December 23rd, 1870.

## APPENDIX XIII. (See Questions 7129-7202 and 7779-7902.)

### AID given to SCIENTIFIC INSTRUCTION and the ADVANCEMENT of SCIENCE by the University of London, and University College, London.

A similar Letter to that addressed to the Heads of the Colleges at Oxford and Cambridge (see Appendix VI., p. 9.) was sent in June 1870 to the Vice-Chancellor of the University of London, and the President of University College, London, and the following statements were received.

#### UNIVERSITY OF LONDON.

University of London,  
Burlington Gardens, W.

June 17, 1870.

Sir,

In reply to the inquiries contained in your letter of the 13th inst., I am directed by the Vice-Chancellor to inform you that the aid afforded to this University by Parliamentary grants, and by endowments for the promotion of scientific instruction and the advancement of science, has reference chiefly to the examinations instituted by this University, particulars of which are contained in the regulations of which I forward you a copy. The examinations, of which scientific subjects constitute the principal part, are those for degrees in science; but the scientific examiners take part also in the matriculation-examination, and in the medical examinations.

The expenses of this University are provided for by an annual Parliamentary grant; the sums received from fees, &c., being repaid into the exchequer.

26060.

The annual expenses of the examinations in scientific subjects (putting aside the maintenance of the general establishment of the University) mainly consist of the salaries of the examiners, which are as under:—

Two examiners in chemistry, 175 <i>l.</i> each	-	350
Two assistant examiners in chemistry, 25 <i>l.</i> each	-	50
Two examiners in experimental philosophy, 100 <i>l.</i> each	-	200
Two examiners in botany, 75 <i>l.</i> each	-	150
Two examiners in geology and palæontology, 75 <i>l.</i> each	-	150
Contingent expenses of practical examinations each	-	60
		£960

For the encouragement of proficiency in scientific study, the following exhibitions and scholarships are annually offered:—

#### First Bachelor of Science Examination.

Four exhibitions, each of 40 <i>l.</i> per annum for two years, in experimental physics, chemistry, botany and zoology	-	£320
--	---	------

Of these, the exhibition in experimental physics proceeds from an endowment provided by Dr. Neil Arnott; the rest are supplied by the Parliamentary vote.

In addition to the foregoing, first B.Sc. candidates can compete with first B.A. candidates for an exhibition of the same amount in mathematics and mechanical philosophy.

4 Q



*Second Bachelor of Science Examination.*

Three scholarships, each of 50*l.* per annum, for two years; in chemistry, zoology, and geology, and Palæontology - - - - - £300

All these are provided by Parliamentary vote.

In addition to the foregoing, second B.Sc. candidates can compete with second B.A. candidates for scholarships of 50*l.* per annum for three years, in mathematics and natural philosophy, and in logic and moral philosophy.

As the exhibitions and scholarships now open to B.A. and B.Sc. candidates conjointly, were provided for candidates in arts previously to the institution of degrees in science, their annual value is not included in the preceding statement.

The sum annually applicable by this University for the promotion of science, is, therefore, as follows:—

Expenses of scientific examinations -	-	£ 960
First B.Sc. exhibitions -	-	320
Second B.Sc. scholarships -	-	300

Total - - - £1,580

Of this total, the sum of 80*l.* is provided by Dr. Arnott's endowment, the remaining 1,500*l.* by Parliamentary vote.

I beg to add, that if the Commissioners should desire any further information in regard to the working of the system of scientific examinations carried on by this University, I shall be happy to afford it, either by letter or by personally appearing before them.

I have the honour to be, Sir,

Your obedient servant,

WILLIAM B. CARPENTER,  
Registrar.

J. Norman Lockyer, Esq.,  
Secretary, &c.

## UNIVERSITY COLLEGE, LONDON.

University College, London,

July 20th, 1870.

SIR, By a circular letter, dated June 17th, 1870, addressed to the President of this College, Her Majesty's Commissioners, appointed to make inquiry with regard to Scientific Instruction and the Advancement of Science, asked to be furnished "with a statement of all sums applied to "the advancement of science or to scientific instruction" in this College; and the President forwarded the circular to me, with directions to prepare the required statement, and to transmit it to you, for the information of the Commissioners.

In conformity with those directions, I now have the honour to forward the accompanying statement, which I beg you to have the goodness to lay before the Commissioners.

I remain, Sir,

Your obedient servant,

JOHN ROBSON, Secretary.

J. Norman Lockyer, Esq., F.R.S.

## STATEMENT OF ACCOUNTS, 1826 to 1869.

## EXPENDITURE.

	£
Freehold land - - - -	30,000
Buildings and furniture - - -	125,070
*Books - - - - -	4,425
Anatomical and materia medica museums -	6,153
Chemical, physical, and physiological apparatus - - - -	4,336
Museum of comparative anatomy and zoology -	602
Birkbeck laboratory of chemistry - -	3,128
Expenditure beyond the College share of fees -	18,393
Do do. do. amount paid to professors in augmentation of fees, and for annuities and pensions - - -	10,180

\* The College libraries consist of upwards of 68,000 volumes and 16,000 pamphlets, a considerable part of which has been derived from gifts and bequests. Last year Mr. James Morris bequeathed to the College, subject to the life interest of his widow, the whole of his valuable library, consisting of nearly 10,000 volumes, and in the course of the present year the College has received 9,982 volumes and 4,377 pamphlets, constituting a splendid library of works on Mathematics, Astronomy, and Physics, being a bequest by the late Mr. J. T. Graves, of Cheltenham, who was formerly Professor of Jurisprudence in the College.

The whole of this money has been provided from the original share capital, from donations, and from legacies, no part whatever of it having been derived from "Parliamentary grants."

The special attention of the Commissioners is respectfully directed to sections 4-9 of the College Act passed last session, copies of which will be found in the Calendar for 1869-70, pp. 177-187.

## Particulars of DONATIONS and BEQUESTS still in hand.

(For particulars of Investments, see A. in the next page.)

## I. General Purposes.

Name of Fund.	—	Annual Income.
Bacon Legacy - - - - -	-	£ s. d. 550 0 0
Hebb " - - - - -	-	12 0 0
Cama Donation - - - - -	-	140 0 0

## II. Special Purposes.

Holme Legacy -	To be applied to the purposes of the Medical Department of the College as the Council shall order.	900 0 0
Atkinson--Morley Scholarships.	For founding and establishing in perpetuity three scholarships for the promotion of the study of Surgery amongst the students of the College.	162 0 0
Filliter Exhibition.	To found an exhibition in Pathological Anatomy.	35 0 0
Fellowes Clinical Medals.	Two gold and two silver medals to be given to the four students who shall most distinguish themselves by reports on the medical cases in the hospital.	15 0 0
Liston Clinical Medal.	Dividends to be applied in defraying the expense of a gold medal to be conferred annually on the most deserving pupil in Clinical Surgery in the College.	8 10 0
Andrews - -	To be applied to the purposes of the College in such manner as the Council shall think fit, the name "Andrews" to be given to any application of the fund.	227 0 0
Hume Memorial	Upon trust for the establishment of scholarships to advance the science of Jurisprudence and Political Economy.	52 0 0
Goldsmid Professorship.	Two-thirds of the income to be applied to or towards the maintenance of a Professor of Hebrew, and the remaining one-third to or towards the maintenance of a Professor of Geology.	36 0 0
Jews' Commemoration Scholarships.	To found two scholarships of 15 <i>l.</i> a year, tenable for two years, for general proficiency.	30 0 0
Ricardo -	Originally devoted to the purchase and maintenance of a library of Political Economy, but, in 1857, the Council resolved to apply the greater part of the income to the foundation of a scholarship in Political Economy of 20 <i>l.</i> a year tenable for three years.	36 0 0
Cook Memorial -	For an annual prize of books in the College School for the highest proficiency in Mathematics and Natural Philosophy.	5 15 0
Holloway -	To be applied in defraying the charges of educating in the School as many boys as the income shall allow, the boys to be thoroughly instructed in the English language, arithmetic, and such elementary parts of the sciences as may be considered useful in their future probable station and employment.	83 0 0
Peene Library -	The interest to be annually applied to the purchase of books, chiefly of foreign literature and science, to augment the library.	53 0 0
Robinson: Flaxman.	The income to be applied towards the preservation, custody, more convenient and complete exhibition to the public, and augmentation of the Flaxman Gallery in the College, any surplus thereof to be applied in the decoration of the Flaxman Gallery, and in the purchase of books, engravings, drawings, and works of art.	90 0 0
Retired Professors.	The income to be set apart, to be paid whenever the Council think fit, to such retired professor or professors as they shall judge to have been least remunerated in proportion to services rendered to the College.	33 0 0
Slade Scholarships.	For the establishment of six scholarships of 50 <i>l.</i> per annum, tenable for three years, to be awarded to the students of the College who shall most distinguish themselves in drawing, painting, and sculpture.	300 0 0
Slade Professorship.	For the establishment and endowment of a Professorship of fine art.	210 0 0

I hereby certify that the foregoing statements are correct, to the best of my knowledge and belief.

JOHN ROBSON,

July 20th, 1870. Secretary to the Council.



## A. INVESTED AND OTHER FUNDS.

	Consols.	New 3 perCents.	Bank Stock.	3 perCents. Reduced.	New 5 perCents.	INDIAN RAILWAY SHARES.					Great Western Railway.
						Bombay.	Madras.	Punjab.	Scinde: Delhi.	Scinde.	
Bacon Legacy, for general purposes	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Ditto, loan to hospital - 3,000l.	—	—	—	—	—	1,144 4 4	—	1,426 4 0	4,632 15 9	1,218 15 0	—
Hebb legacy, for ditto	412 12 10	—	—	—	—	—	—	—	—	—	—
Gama donation	—	—	—	—	—	—	—	—	—	—	—
Holme Fund, for the purposes of the Medical Department of the College	—	—	2,700 0 0	—	—	2,855 15 8	10,000 0 0	3,573 16 0	—	—	—
Atkinson-Morley Surgical Scholar- ships' Fund.	—	—	—	—	3,870 7 0	—	—	—	—	—	—
Do. do. Accumulation of dividends.	—	—	—	—	109 4 8	—	—	—	—	—	—
Filliter Exhibition Fund	—	—	—	—	806 18 7	—	—	—	—	—	—
Dr. Fellows' Clinical Medal Fund.	—	500 0 0	—	—	—	—	—	—	—	—	—
Liston Clinical Medal Fund.	—	292 9 3	—	—	—	—	—	—	—	—	—
Andrews' Fund: Exhibitions, Prizes, and Scholarships for Proficiency in General Literature and Science.	—	—	—	—	4,070 2 3	—	—	—	—	—	—
Ditto Accumulation of dividends.	—	—	—	—	—	—	—	—	—	—	—
Hume Memorial Fund: Scholar- ships in Jurisprudence and in Political Economy.	178 10 11	—	—	—	603 15 0	—	—	—	—	—	—
Ditto Accumulation of dividends.	—	—	—	—	1,000 18 5	—	—	—	—	—	—
Goldsmid Professorships' Fund	—	—	—	—	62 1 2	—	—	—	—	—	—
Jews' Commemoration Scholar- ships' Fund.	1,000 0 0	—	—	—	—	—	—	—	2,780 4 3	—	—
Ricardo Fund: Library and Scholarship in Political Economy.	—	—	—	—	407 17 9	—	—	—	—	—	—
Ditto Accumulation of dividends.	—	—	—	—	—	—	—	—	—	—	—
Holloway Fund: School Exhibitions	—	—	—	—	380 9 8	—	—	—	—	—	—
Cook Memorial Fund: an annual school prize for proficiency in Mathematics and Natural Philo- sophy.	—	—	—	—	2,030 8 0	—	—	—	—	—	—
Peene Library Fund: for the pur- chase of books, chiefly of Foreign Literature and Science.	—	—	—	—	141 0 0	—	—	—	—	—	—
Peel Memorial Fund: Income applied in gifts of books, maps, and other aids to knowledge, to Mechanics' Institutions, &c.	1,745 15 1	—	—	—	1,204 7 7	—	—	—	—	—	—
H. Crabb Robinson Fund: for keep- ing up Flaxman Gallery, &c.	—	—	—	—	—	—	—	—	—	—	—
Retired Professors' Fund	1,058 4 0	—	—	—	—	—	—	—	—	—	2,000 0 0
Library Deposit Fund	—	—	—	—	—	—	—	—	—	—	—
Reserve Fund	—	959 5 8	—	—	73 13 5	—	—	—	—	72 8 0	—
Brundrett Fund (reversionary after the death of annuitants) 1,144 lls. 5d.	—	—	—	—	—	—	—	—	—	—	—
Hollier Fund (reversionary after the death of Mrs. Hollier).	—	—	—	4,907 11 10	—	—	—	—	—	—	—

## APPENDIX XIV. (See Question 7483.)

PAPER handed in by Professor MASKELYNE.

In my evidence I allude to a subject on which I proposed to make a suggestion to the Commission: namely, the removal of the Mineralogical Collection to South Kensington, with the rest of the collections appertaining to natural history.

The suggestion I would make in regard to this removal is, that the biological collections, that is to say, those of the zoology and botany, together with that of palæontology (now called geology), should be united to form a National Museum of Biology; and that the Mineralogical Department should hereafter be combined with the Government School of Mines, wherever that institution may ultimately find its home, provided that its distinctive character be preserved.

So long as the British Museum might be retained in its integrity, or its collections might be regrouped into distinct divisions at the present locality, the mineral collection would seem to be in its place among them. But when once a separation of a part of these collections from the rest is determined on, the logical position of a collection of minerals in the midst of a series of biological collections assumes a new and very questionable phase.

The division of created things into animal, vegetable, and mineral is no longer exhaustive; it no longer represents the whole world known to science. Organic chemistry and the sciences that deal in organisms treat of certain forms of matter that are organic from one point of view and yet are not organic from another, and even inorganic chemistry deals in substances that can only be called mineral by using the word in what must, even in the present age, be termed an ambiguous sense. The place of a collection of minerals is cer-

tainly either by the side of the crystallised products of the laboratory, that is to say, it should aid in illustrating the science of chemistry, or that place is to be found where minerals are most completely studied, technically as well as scientifically, that is to say, where mining is especially taught.

The term mineralogy, in fact, inadequately represents the purport of a science the limits of which should include the morphological and the classificatory problems of chemistry; for the mineralogist, in his capacity of crystallographer, makes a study of the former, and, in the arrangement of a mineral collection, seeks to solve the latter class of problems, but does so with only such of the products of chemical combination as he meets with ready formed in nature. It would certainly be well if the traditional perversity which has confined mineralogy to natural chemical products should be broken through in the case of the National Collection of Minerals, which is now by far the first in the world, and which might then be expanded into a complete collection, illustrating all definite chemical products, whether formed artificially by the chemists' art, or found naturally produced by the processes in operation in the great laboratory of nature.

The collection taking this development is not at all inconsistent with its being connected with the School of Mines. That school, under any form that may be given it, must retain, as a part of its system, instruction in chemistry, and a great collection of natural and artificial chemical compounds would be quite appropriately placed in juxtaposition with the other collections, illustrative more immediately of mining industry and its products.

The study of natural minerals in their relation to



mining will always be necessary, as will collections to illustrate it. The National Collection would well subserve that purpose for a National Mining School; and it would best be retained in connexion with such an institution, as the additions to its strictly speaking mineral part, which, it is to be remembered, will always be expensive, and will need a special education on the part of the Keeper, would be more likely to be kept up in such a connexion than if the collection were attached as an appanage to some great chemical laboratory, where its mineral element would be liable to be lost sight of or overgrown by the purely chemical laboratory element. For these reasons, I consider the School of Mines and Metallurgy to be the best and most practical destination for the Mineral Department of the British Museum under the supposed change in the distribution of the collections; and I think this is equally so, whether the objects embraced in this col-

lection be confined, as at present, to natural minerals, or whether the limits of that collection be enlarged in the manner I have proposed, so as to embrace artificially formed "mineral" or chemical products.

I consider, also, that it is equally the best and most logical destination of the collection, whether the School of Mines be retained where it is, or be removed to another site.

Under any circumstances, a gallery must be built to contain the mineralogical collection, and the cost of building it will not be very different, whether it be associated with the Biological Museum or with the School of Mines. But I beg leave to place on record, and in the hands of Her Majesty's Commissioners, my strong opinion that the least appropriate destination of this collection would be in association with a Biological Museum.

N. STORY-MASKELYNE.

## APPENDIX XV. (See Questions 7739-40.)

PAPER handed in by Mr. CARRUTHERS.

I had carefully read and considered the proposals contained in the anonymous communication on "Botanical Museums," published in "Nature" on the 23rd March last, and was fully prepared to deal with them had they been made the subject of examination. Indeed, at the close of my answers to questions 7739-40, I was proceeding to deal with them, when I was interrupted by a question which gave a different direction to my examination. I treated the communication in "Nature" as one is accustomed to treat anonymous papers, estimating only the value of its arguments. Now, however, as it appears with all the weight which the name of Mr. Bentham carries with it, I desire to submit to the Commissioners my views:—

1st. On the statements contained in the paper,

And, 2ndly, on the matters naturally flowing out of those statements.

### I. The statements contained in the paper.

1. The views expressed by Mr. Bentham regarding the main purposes of a botanical museum and herbarium, and the requirements of a collection for such a close study of plants as would supply a "sound foundation upon which the science of botany can be usefully established," arise from his estimating the science of botany as limited to that particular department of it to which he has devoted his life, and in which he has done important service. The profound study of plants is, in his view, "their accurate determination and practical classification," and he states that he requires for its prosecution nothing more than an exhaustive herbarium of the fragments of plants supplying the diagnostic characters at present employed for distinguishing genera and species, with a complete library and staff of officers. This is, in my opinion, a very defective estimate of the science of botany, and of the materials required for its advancement.

Robert Brown took a very different view of the profound study of plants, and in the Botanical Department of the British Museum he tried to develop that masterly grasp of the science which is to be found in his works, by illustrating, as far as possible, the structure of all the parts from the lowest to the highest, both existing and extinct. Accordingly, the National Herbarium, large as it is, forms but a part of the Botanical Collections. The specimens placed in the outer rooms, which exhibit chiefly the form and structure of the stems and roots of plants, are as necessary a part of the purely scientific collection as the dried foliage and flowers in the herbarium. While such specimens "excite the interest," and "gratify the curiosity" (and, what is more important, instruct the minds) "of the general public," these are very far from being their principal, still further from being their only purpose in a botanical museum, as Mr. Bentham appears to imply. The scientific investigator,

whose notion of systematic botany is somewhat larger than ascertaining the technical name and Order of a plant, consults these specimens as he does the herbarium. It is, therefore, a mistake to suppose that they, "when once placed, require no further handling."

The purely scientific collection of the British Museum consists of:—

#### I. The herbarium, comprising,

- a. The General herbarium.
- b. The British herbarium.
- c. Various separate small and complete herbaria of historical interest.

#### II. The Structural series, comprising,

- a. The fruit collection.
- b. The collection of gums, resins, and other natural products.
- c. The general collection, exhibiting the form and structure of plants, and consisting of the larger specimens chiefly exhibited to the public; and
- d. The Microscopical preparations, illustrating the minute structure of recent and fossil plants.

2. The limitation of the science of botany to the plants now existing on the earth is another grave defect. No subject has recently received more attention from biologists than the relation between existing and extinct plants and animals. Every philosophic estimate, or systematic classification of the one kingdom or the other must include the fossil as well as the recent. This is fully acknowledged and acted upon by zoologists, and no better illustration can be adduced than Professor Huxley's "Introduction to the Classification of Animals" (1869). In botany, also, in the standard and only complete *Genera Plantarum*, by Endlicher, the fossils are ranged in their systematic position with the recent plants. It is true that the *Genera Plantarum* now in progress, of which Mr. Bentham is one of the authors, ignores all extinct plants. This retrograde step is in entire accordance with the views expressed by Mr. Bentham in "Nature." A systematic account of the *Lycopodiaceæ*, which took no notice of the arborescent forms of the palæozoic age, or of the *Cycadeæ*, which ignored the numerous forms and remarkable variations of this order in the secondary rocks, would be obviously very incomplete and unsatisfactory. In forming a collection to supply a sound foundation for the science of botany, it would be as reasonable to exclude the plants of any existing botanical province—say Australia—as to omit those which have existed at any particular period of the earth's history—say that of the Wealden.

3. The distinction which Mr. Bentham draws between a herbarium "for the close study of plants" and one for their "rapid determination without dissection" is most undesirable, and, in my opinion, practi-



cally impossible. No botanist has so extensive an acquaintance with the vegetable kingdom as to be able to make "a close study," in his necessary work, of every group of plants he may be naming or arranging; he must in many groups make a "rapid determination without dissection." If Mr. Bentham's distinction were in force, and the two herbaria he proposes existed, he would himself, when rapidly naming some of the important collections which have passed through his hands, have often been driven from the great scientific collection to work in his single specimen herbarium with the "general naturalist," "the palæontologist," and "the mere amateur." Every systematic botanist is at first, and more or less all along, a "comparer" of plants. The man who begins as a mere comparer, naturally becomes a close student under the influence of the collection he is consulting, and the workers he encounters in that consultation.

4. Mr. Bentham's single specimen herbarium is chiefly intended for the palæontologist, and, in addition, he proposes to provide him with "separate" collections of leaves and fruits, \* \* so arranged "as to enable them to be rapidly glanced over," and these, it is added, "would be most useful." No better testimony to the utter worthlessness of such materials for the purpose proposed can be adduced than the criticisms of Mr. Bentham himself, on the evidence for the existence of the natural order *Proteaceæ* in Europe, from leaves found in Tertiary strata. Mr. Bentham was specially fitted to deal critically with the hundred fossil species referred to this Order, as he had just made the analysis and detailed descriptions of between five and six hundred *Proteaceæ*. The Order is also the best fitted to test the value of the leaf characters on which the fossils had been referred to it, because, as he testifies, it "is one of the most distinct" and most clearly defined amongst phanerogams, and is without "a single plant intermediate in structure between that and the nearest allied Orders." With regard, then, to the leaves of this Order, Mr. Bentham says: "I must admit that there is a certain general '*facies*' in the foliage of this Order that enables us, in most, but not in all, cases, to refer to it with tolerable accuracy—leafy specimens known to have come from a proteaceous country, even without flowers or fruit—but as to detached leaves, I do not know of a single one which, in outline or venation, is exclusively characteristic of the Order, or of any one of its genera." I cannot reconcile this declaration by Mr. Bentham, to the Fellows of the Linnean Society, as their President, in May 1870, with the statement published by him within a year thereafter, that such a collection of detached leaves, not for a limited and exceptionally defined Order, but for the whole vegetable kingdom, "would be most useful."

I must further observe, that Mr. Bentham has overlooked the fact that a large proportion of fossil plants have been determined from their internal structure, that is, on evidence which no mere herbarium, however extensive, can supply, far less one for rapidly determining plants without dissection, or a collection of detached leaves. The palæontologist requires the most extensive collections possible for his work, and he must be a working zoologist or botanist. All such work done by mere "geologists," and on such data as Mr. Bentham proposes to supply, would always deserve strong condemnation.

II. In considering the matters naturally flowing out of Mr. Bentham's paper, and the views I have now expressed, I venture first to submit the reasons which make it desirable, in my opinion, to retain the two herbaria as separate and independent institutions.

1. The two herbaria already exist, and are, to a considerable extent, parallel collections. Mr. Bentham, whose extensive private herbarium formed the foundation of the public herbarium at Kew, declared, in 1858, "that a great portion of the additions to the Banksian herbarium, since Sir Joseph's death, are duplicates of those already at Kew." As the Banksian plants form less than a quarter of those now existing in the

British Museum herbarium, the duplicates would be, according to Mr. Bentham, about three fourths of the whole. Sir William Hooker, also, whose large collections form the great bulk of the Kew herbarium, testified, in 1858, that "the Museum specimens are to a great extent duplicates of those at Kew." And the present Director of Kew Gardens corroborated this statement at that time. In 1860, Sir William Hooker further said, in reference to the transfer of the National Herbarium to Kew, as affecting the herbarium there, "To Dr. Hooker and myself it literally and truly can be a matter of no consequence."

2. The two herbaria have been under different management, and, to some extent, express different results of "the close study of plants." The important bearing of this consideration on botanical science in Britain can scarcely be overestimated. One practical illustration may be adduced. The most varied views are entertained by botanists as to the limits of a species, and consequently as to what constitutes a duplicate. Thus, in the case of the indigenous flowering plants of Britain, Mr. Bentham considers them to form 1,274 species; Dr. Hooker, in his recent *Flora*, makes 1,473 species; Professor Babington increases the number to 1,648 species; while a botanist adopting the views which Jordan and some continental authors have applied to local floras, would make them three or four times more numerous than even the last estimate. It is quite obvious that these different botanists have each very different notions as to "duplicates," and that a distribution undertaken by Mr. Bentham would certainly result in the loss to the herbarium of plants which Dr. Hooker would consider good species, and the "duplicates" distributed by Mr. Bentham or Dr. Hooker would include numerous plants which would be of the utmost value in M. Jordan's eyes. The two herbaria, existing, as they do, under different directors, to a considerable extent counteract these and other analogous evils.

III. The objects of the two herbaria are fundamentally different, and, in as far as they fulfil their objects, they are employed for totally different purposes. The National Herbarium at the British Museum was founded in 1827 for the use of the scientific botanist, while that at Kew was, as Dr. Hooker says, "originally maintained expressly for the use of the gardens." This was the primary object for which Sir W. J. Hooker accepted the private herbarium of Mr. Bentham in 1855. Before that year the gardens had been fulfilling their proper functions without a scientific herbarium attached to them. The two editions of the "*Hortus Kewensis*" are the best testimony to the efficiency of the gardens, and to the value of the collections brought together there under the Aitons. No herbarium of any kind, I believe, existed at the gardens during their time. The Banksian Herbarium was often, and for a long time, systematically used for naming the Kew plants; and the strictly scientific portion of the "*Hortus Kewensis*" was the work of Solander, Dryander, and Brown, the successive Curators of the Banksian Herbarium. Even Sir W. J. Hooker, the successor of the younger Aiton, who raised the gardens to their present eminence, had no public herbarium from the time of his appointment in 1841 till 1855. It is, therefore, evident that a great scientific herbarium is not a necessity to the efficiency of the Gardens at Kew.

It is, however, certain that such a herbarium as Sir W. J. Hooker and Dr. Hooker desired, that is, one sufficient to enable the officials to name the plants in the gardens, would be a most useful adjunct at Kew, as it would save the great waste of time which would be incurred in consulting a herbarium at a distance. Inasmuch as growing plants are, to the extent that they are developed, perfect, and permit thorough examination, it is obvious that the single specimen herbarium, proposed in "Nature," would meet all the requirements at Kew; and this could be kept up, as suggested by Mr. Bentham, from the duplicates not required in the great National Herbarium, all being accurately named before being sent.

Return to House of Commons, No. 126, p.

Evidence before the Select Committee on the British Museum, 1860, p. 100.

Handbook of the British Flora.

Report by Sir W. J. Hooker, on Kew Gardens, in Civil Service Estimates for 1870-76.

Report by Sir W. J. Hooker, on the Progress of Kew Gardens, 1860, p. 10.

Vol. III. P. 49.



IV. The practical difficulties in the administration of two separate, and to some extent independent, herbaria would be numerous and serious, and, in the course of time, a condition of things similar to what at present exists would result. It is needless to speak of a London herbarium, consisting of single specimens of each species, because such a herbarium, if practicable, would, as I have already shown, be utterly worthless for the purposes to which it is proposed to be applied. If the London herbarium were to contain only specimens sent by the keeper of a herbarium whose notion of the science of botany was confined to the "accurate determination and practical classification" of herbarium specimens, it is obvious that the palæontologist would not find there the materials for prosecuting his work. If, on the other hand, the London herbarium were constituted to be of real use to the palæontologist, the keeper must have the power of acquiring, as opportunity offered, the suitable materials, and he would necessarily secure collections which a future agitator might demand to be transferred to Kew, with as pertinent reasons as those Mr. Bentham now employs.

V. It is not an unimportant consideration that the continued separate existence of these two great herbaria is a great security against their destruction by fire.

VI. The expense of the two herbaria is very small. I am unacquainted with the amount granted for Kew herbarium, but it cannot greatly differ from that required by the National Herbarium, which amounted for the financial year lately completed to 1,767*l*. I know of no way in which the country can at once advance the interests of science and encourage its students at a smaller cost and with more important results than by maintaining in their full efficiency the two botanical collections at present existing.

It must be admitted that the formation of a single great National Botanical Establishment, comprising the two public herbaria now existing within a comparatively small distance from each other, is a very attractive scheme, and should the Commissioners think that its realisation is desirable, I submit the following considerations as, in my opinion, essential:—

I. It must form part of the National Museum of Natural History. Such a museum, as far as it is an exhibition of biological science, will consist of animals and plants, both existing and extinct. It is absolutely necessary, in the study of geology, that the plant remains should not be separated from the animal remains; and, further, it is as necessary for the satisfactory interpretation of the fossil plants, as well as for forming a true estimate of the vegetable kingdom, that the recent plants should not be separated from the fossil. The separation of any one department would be a serious injury to all.

II. It must represent the whole science of botany, and not consist of only dried foliage and flowers, which constitute a herbarium properly so called; and, consequently, it must be formed on the principle adopted by Robert Brown, and exhibited in the Botanical Department of the British Museum, and not on the imperfect plan advocated by Mr. Bentham.

III. It must be placed in the position in which it will be most serviceable to the public, and most accessible to botanists, and that place is, beyond all question, London. The statistics which I submitted on the occasion of my examination establish this, by showing the extent to which the botanical collections at the British Museum are made use of. Further, it is universally acknowledged that a herbarium for scientific use must exist in London. The long experience of Mr. Brown and Mr. Bennett in the National Herbarium made them entertain and express very decided views as to this necessity. My shorter experience has been long enough to convince me that its removal to Kew would be practically placing it out of the reach of the busy men who frequently use it to the advantage of science. Of course, the working botanist who devotes himself exclusively to the science

would follow the collections wherever they went; but the active professional man, and the man of business, who devote their spare hours to botany, would be deprived of the assistance necessary to their work which they now obtain at the British Museum. That such men do a large proportion of the scientific work of the country may be shown in many ways, as, for instance, by the fact that out of the 19 botanical memoirs contained in the last two volumes of the Linnæan Transactions, four are produced by professional botanists, and 15 by others.

The late Professor Henfrey,<sup>(1)</sup> as representing the botanical teachers of London, Sir Charles Lyell,<sup>(2)</sup> for the palæontologists, and Dr. Falconer,<sup>(3)</sup> Mr. Bentham,<sup>(4)</sup> and Dr. Hooker<sup>(5)</sup> have recorded it as their decided opinion that the interests of science require that a public herbarium should exist in London. Such a herbarium, even if used only by palæontologists, must be, as I have shown, as extensive as possible; otherwise, it will tend to mislead, like all other imperfect sources of information.

I would further add, in favour of London being the proper site for the National Botanical Collections, that important collections of plants, both recent and fossil, accessible to students, but not to the general public, now exist and must still remain in London. These are: 1st, the Linnæan herbarium, containing the plants described by Linnæus; 2nd, the great Wallichian herbarium; 3rd, the Smithian herbarium of British plants, all belonging to the Linnæan Society; 4th, the collection of fossil plants belonging to the Geological Society; and, 5th, the extensive public collection of fossil plants in the Museum of Practical Geology. The removal of the National Botanical Collection from London would so separate them from these collections as seriously to injure their value to scientific investigators.

IV. The accommodation provided for the Botanical Department in the New Museum of Natural History, the plans of which have been accepted by the Trustees of the British Museum, will be in every way superior to any that exist in the world, and will be amply sufficient to accommodate the proposed single National Herbarium, as well as fully to display the structural, histological, and palæontological departments of the science. All the requisites specified by Mr. Bentham for the close study of plants, excepting the connexion with a garden, exist to a greater or less degree at the British Museum, and some of them in a greater degree than at Kew. That living plants are a requisite adjunct to a herbarium, is in opposition to the testimony of Mr. Brown and Dr. Falconer, to the effect that there is no necessary connexion between a herbarium and a garden; and is opposed, moreover, to the testimony of Mr. Bentham himself, as well as to his declaration that his extensive systematic labours have all been based on herbarium specimens, although they have been carried on in close proximity to the finest scientific garden in existence.

In the event, then, of its being resolved to maintain only one great national botanical collection, I would submit that it should not be cut off from the allied biological collections, but be placed with them in the same building in London. And that, for this end, the collections presented by Mr. Bentham to the public, and all that have been added to them by purchase or presentation, be removed to London and incorporated with the National Herbarium; and, further, that the extensive botanical library formed at the national expense at Kew be made, with the Banksian library, the foundation of that National natural history library which will be required for the National Museum of Natural History.

It is necessary, in dealing with Mr. Bentham's printed and publicly expressed views on this matter, to bear in mind that he cannot be considered an unprejudiced witness. I have frequently referred to his relations to the herbarium attached to the Royal Gardens at Kew. He has thus stated the reasons by which he was influenced in presenting his herbarium and library to the

(1) Return to House of Commons, No. 126, p. 7.

(2) Return to House of Commons, No. 126, p. 10.

(3) do. p. 9.

(4) do. p. 6.

(5) Memorandum respecting the Botanical collections of the British Museum and Royal Gardens, Kew, p. 3, 31st December 1868.

Nature, Vol. III. p. 401.

Return to House of Commons, p. 126, p. 2.

Return to House of Commons, No. 126, p. 7.



Return to  
House of  
Commons,  
No. 128, p. 7.

public in 1855:—"I thought that, at that time, there was no herbarium and library in London sufficiently open for the use of botanists, and I presented them on condition that they should form the nucleus of a national herbarium and botanical library, to be kept at the expense of Government, and open to the free use of botanists." I can assert, in opposition to Mr. Bentham's belief—and a similar opinion has been, I understand, recently expressed—that at that time the National Herbarium and the National Library, as far as it is an adjunct to the herbarium, were fully and freely accessible to botanists, and were largely used by botanists; and this I am able to maintain from the contemporary records of this Department, as well as from the testimony of botanists who were then

in the habit of consulting the collections. Under the influence of this erroneous supposition, Mr. Bentham made his own herbarium a national institution, and a rival to the Banksian Herbarium, and, under the influence of this same spirit of rivalry, he now believes that there exists "a state of continual competition" between the two herbaria. I am sure that Dr. Hooker, and the authorities at Kew, will as strongly repudiate this statement as I do now, if it is meant to imply a competition in any way to the injury of science or the public. It is only in keeping with the motives which actuated him at the first that Mr. Bentham now agitates for the incorporation of the Banksian Herbarium with that of which his own forms the nucleus.

Nature,  
Vol. III.,  
p. 491.

## APPENDIX XVI.

EXTRACTS from the *Reports for 1867 and 1868 of the Committee of Governors of the Worcester, Lichfield, and Hereford Training College*, of which the Rev. Canon Gover is Principal.

The cry for technical education, though, perhaps, not very intelligent or clear, points to a more extended training. It indicates dissatisfaction, as regards the amount of intelligence brought out, and of power given to our workmen, with the shortcomings of the present system of elementary education.

Formerly, a third year of study for special subjects was recognised, and at one time, indeed, a residence of three years was all but imposed upon the training colleges by the Committee of Council, whilst, in the second year, alternative subjects, diversely chosen by the officers of the various colleges, formed part of the second year's course. The alternative subjects have been withdrawn, and the system, throughout the colleges, has been compressed into a rigid uniformity; the third year's course has been abolished, and therewith the best preparation for assistants on the staff of the training colleges themselves.

The examinations of the Department of Science and Art, in various subjects, seem to offer a remedy. Although your committee think it undesirable that any of these subjects should be taken up by the students during the second year's course, unless such as fall in with it, yet these examinations afford the means of partially restoring the third year's studies. The Committee of Council, it is to be hoped, will recognise the *continued residence of selected students* for these examinations. Accordingly, this experiment has been set on foot by your committee; and a sub-committee and classes have been formed in accordance with the requirements of the Department.

On another subject of general interest with reference to training colleges, their concern with technical education, and the connexion which has sprung up among them with the Department of Science and Art, it is expedient to make some remarks. In the Report of the Committee of the House of Commons, of which Mr. Samuelson was chairman, one of the recommendations is—

"That the managers of training colleges for teachers of elementary schools should give special attention to the instruction of those teachers in theoretical and applied science, where such instruction does not exist already."

But the Committee of the House of Commons do not appear to have been aware that the training colleges cannot, as formerly, elect the subjects in which they will seek examination. This was, indeed, the system at first pursued; but it has long since been superseded by the course laid down in the syllabus, and, from time to time, more and more narrowly contracted at their will by the Committee of Council, to an undeviating uniformity of subjects. The very same course and subjects of instruction, under existing arrangements, are prescribed to, and required from the student in a metropolitan college, in a college amongst the keenest activities of manufacturing life, or in a Welsh college, preparing teachers for remote agricultural valleys and a population strange to, or unversed in the English tongue.

The re-action from this rigid curriculum has found expression in the introduction of science classes (so popular amongst the students that the authorities of the training colleges are constrained to go along with the movement) in connexion with the Department of Science and Art.

Yet, there is much in this movement of obvious good. The students are not herein examined in a close and exclusive class, limited to those only who are to be of their own profession. On the contrary, they are thrown into open competition with the minds most athirst for know-

ledge to be found among those engaged in numerous callings, of which the social rank is not very different from their own. They take their place, as it were, in a republic of letters for all those eager intellects, who would carry on to special subjects the education gained in the best of our elementary schools.

Still, the distraction incident to preparation for two distinct examinations under separate departments is not without its disadvantages.

It would be better if the former diversity of studies in the various colleges could be restored by the co-operation of the two Departments of the Education Office.

It would go further still to meet the demand for technical education, if the colleges could retain, after the two years' course was finished, selected students to prepare for special subjects in the following May examinations of the Department of Science and Art.

This experiment, indeed, your committee, in the beginning of 1868, endeavoured to carry out, as they believed, with the concurrence of the Education Department. The class list for the subjects in which their students sought examination appears in the present Report (page 52). With regret, then, your committee learnt that, in the opinion of the Council Office, existing Minutes would not warrant this extension of the time of training; and they have, therefore, been compelled, with great reluctance, to suspend their design.

In one subject in which the Education Department authoritatively avails itself of the Syllabus of the Department of Science and Art, namely, Drawing, some modification seems requisite.

At present, the certificate for competency to teach drawing is given for passing in the second grade. Now, many students have reached or nearly reached this at the end of their first year; some even when they enter the college. But the third grade, or art teacher's certificate, lies so far beyond the second, and involves the expenditure of so much time in the preparation of the prescribed group of works, as to make nearly hopeless the attempt to reach it in the portion of time which the college can allot to drawing.

Yet, it is most desirable that those who have evinced more than ordinary talent or taste in this direction, should not be left to fall back from the proficiency they had acquired, or be kept with the body of the students, reiterating work they have already mastered.

Considering the importance of drawing to the school-master, whether for the power which it confers on himself in his methods of teaching, or for the use he can make of it as a subject of instruction, a recognised intermediate stage, between the certificate of the second grade and that of the art teacher, appears to be called for.

RESULT of the Examinations of the Science Classes held in connexion with the Science and Art Department, May 1868.

### *Animal Physiology.*

Class I.—Daphne. Mapp.

### *Geology.*

Class II.—Daphne. | Class III.—Mapp, Spencer.

### *Physical Geography.*

Class I.—Daphne (1867), Powell (1867), Timms (1867).



Class II.—Bates (1867), Bullock, Jackson (1867), Mapp (1867), Heath, Woodward.

Class III.—Binner, Butler, Booth, Cowlshaw, J. Doyle, Eccleston, Hingley, Lea, Riley, Sargeant, Padfield (1867), Pedley (1867), Spencer, Williams.

#### *Elementary Mathematics.*

Class I.—Mapp.

Class II.—Bullock, Daphne, Doyle, Williams.

Class III.—Binner, Booth, Butler, Heath, Lea, Sargeant, Woodward.

#### *Theoretical Mechanics.*

Class II.—Mapp. | Class III.—Doyle.  
Class V.—Spencer.

#### *Practical Plane and Solid Geometry.*

Class II.—Daphne, Doyle. | Class 3.—Mapp.

All in the first three classes in each subject received Queen's Prizes; those in the first two classes are qualified to become science teachers.

N.B.—The science classes in connexion with the College were only established at the end of January 1868.

## APPENDIX XVII.

### REPORTS FROM EXAMINERS under the SCIENCE AND ART DEPARTMENT.

The following Letter was addressed to the Professional Examiners for Science under the Science and Art Department of the Committee of Council on Education, South Kensington, on the 15th of June 1871.

Royal Commission on Scientific Instruction and the Advancement of Science,  
6, Old Palace Yard, S.W.

SIR, June 15th, 1871.

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to ask you to be so good as to aid the Commissioners in their inquiry by answering (with the least possible delay) the following questions with reference to the examination papers, under the Department of Science and Art, for 1871.

1. What opinion have you formed as to the amount of good which is done by the South Kensington System generally, and the value of the examination in the different grades?

2. What is the evidence afforded as to the practical nature of the teaching?

3. What opinion have you formed as to the amount of "cram," and the power of testing it by examination?

4. What test is afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher?

5. Whether any evidence is afforded, in the badly spelt and ungrammatical papers, that they are, as a rule, the work of young persons?

I have the honour to be,

Sir,

Your obedient servant,

J. NORMAN LOCKYER,  
Secretary.

The following replies were received:—

Royal Military Academy, Woolwich.

SIR, June 25, 1871.

IN compliance with the wish you have done me the honour of expressing, I beg to submit the accompanying report, premising:—

1st. That I have had no experience as inspector of schools connected with the Science and Art Department, and but a few years' connexion with it as examiner, and, therefore, my knowledge of the inner working of those schools must necessarily be limited, and my opinion of little weight.

2nd. That my subject is a peculiar one—one that is only of late years fully recognised as a necessary branch of education, and, consequently, much in want of a text book within every one's reach—one, moreover, that requires a considerable amount of previous mathematical training, if any extensive knowledge of it is required, or (for even an elementary course) models and aids to learning which are not attainable by all who take it up. I must beg, therefore, that the exceptional nature of the case may be taken into consideration while reviewing my remarks upon the results that have passed through my hands. I beg to submit that the teachers, owing to the system of payment by results, are too apt to look upon the Science and Art Department as having been established to supply a source of income for themselves, rather than for the promotion of education, and, owing to this feeling, resent any innovation or alteration in the style of examination, or in the course of study in any given subject, which they think will interfere with the number of their successes in that subject. They appear to insist upon having a minute syllabus of the course of study requisite for any subject taken up for examination, and any deviation from this syllabus, or even the setting of a question in a form not familiar to them, is made the subject of dire

complaint. In my own case—when first appointed examiner in subject I,—I offended in both these respects, and the letters of remonstrance from teachers were many, and bitter in tone. Some averred that the questions were impossible, others, that they were beyond the reach of ordinary mortals, and one, that I knew little or nothing of the subject. This was because the syllabus laid down in the Directory had not been exactly adhered to.

Now, I beg to submit that teachers ought not to be permitted to dictate to the Department or the examiner in reference to any particular examination which is intended to test general knowledge in a certain subject, and that the syllabus should give the barest outline of the subject or grade of subject it refers to, merely indicating the points at which the course of study in that subject should begin and end.

I would also beg to submit that more stringent rules should be established, and carefully carried out by committee and inspectors, to prevent students attempting too much, and to prevent teachers from encouraging them in those attempts. I would suggest that some means should be devised by which a student should be debarred from taking up an "advanced" paper in any subject unless he had previously obtained a class in the "elementary," or from attempting an "honours" paper till he had passed well in the "advanced." The difficulties to be met with in carrying out this system would doubtless be great, and, equally doubtless, have been under the consideration of the Department.

In consequence of the plain evidences of the "cram" system pursued, which are afforded by the results that have passed through my hands, I beg leave to give my unqualified opinion that no student who has obtained even a first class, in either first or second grade, should be allowed, on the strength of that success only, to constitute himself a teacher of others. (I again beg to remind you that I am speaking only from experience in my own peculiar subject.) In the case of "honours," things would be different. A successful candidate in that grade would probably be well qualified to undertake the tuition of beginners, being most likely experienced as a draughtsman, and well grounded and practised in mathematical reasoning.

One of the questions submitted for my consideration has reference to the writing and spelling of the candidates. On this point I am but little qualified to form an opinion, as in my subject scarcely any writing has been hitherto required. The words scholarship, exhibition, problem, or, now and then, a word or two of explanation, have been the only means that I have as yet had of judgment on this point, but I have always considered the handwriting to be very fair, indeed, and do not remember any instance of flagrant mis-spelling. This year I had a question in my paper that required a short written answer, and on conferring with my assistants I find that we are agreed that both spelling and writing were on the whole very good.

I have only to add that if I can possibly afford Her Majesty's Commission information upon any other points connected with my position as examiner to the Science and Art Department they have only to command me.

I have, &c.

F. ALF. BRADLEY.

To the Secretary,  
Royal Commission on Scientific Instruction.

The College, Homerton, E.,

SIR, July 14, 1871.

I HAVE the honour to acknowledge the receipt of your communication dated June 15th. My absence from



England has prevented an earlier reply. A copy of your letter forwarded to me failed to reach me while abroad.

My connexion with the Science and Art Department has not been of long duration. I have superintended only two examinations in machine construction and drawing. Further, I ought to remark that there, is at present, a special difficulty in securing the proper teaching of the subject in which I examine. There are no satisfactory English Text-books of machine design of an elementary character. In Germany and in France some progress has been made in reducing to method the principles of machine design, and treatises have been prepared for use in polytechnic schools, for which, at present, we have no equivalent. Such materials as exist in our engineering literature are either contained in treatises too difficult for use by the class of students who come up for these examinations, or are scattered in a fragmentary way through treatises on special departments of engineering. The result is, that, whilst machine drawing is fairly taught, machine design is, at present, hardly taught at all. Subject to these remarks, I have pleasure in returning the following answers to the questions of the Commissioners:

1. In forming an opinion as to the good effected by the science examinations, three points may be considered:—(a.) Whether the examiner can, by the form of the examination paper, direct and gradually improve the character of the instruction; (b.) whether the system of the Department secures fairly competent teachers; (c.) lastly, whether it creates sufficient interest to secure the formation of classes and the attendance of students.

I am of opinion that the examiner has the power, to a considerable extent, to direct and shape the teaching. Recommendations which I thought it desirable to make after the examination in 1870, had, I believe, the effect of improving the character of the teaching, especially in the better schools, and the results in 1871 were more satisfactory than in 1870.

As to the competence of the teachers, I must speak with rather less satisfaction. In many of the schools the teaching is good, but many of the teachers have not sufficient practical acquaintance with the details of machinery to render their teaching effective. Probably an examination, which is mainly an examination in drawing, appears easier to many than it really is, and thus the teachers are tempted to send up students who are unprepared to pass the examination. It is to be hoped that the failure of inefficient teachers to pass their students, the gradual improvement of the more efficient teachers, and, above all, the introduction of suitable elementary text-books, in this subject, may in time secure a higher standard of teaching.

As to the third point mentioned above, nearly three thousand students offered themselves for examination in machine construction last year, a number so large, that it is evident that a considerable stimulus to instruction in this subject is created by the system of the Science Department.

2. The question of the Commissioners as to the practical nature of the teaching has already been answered in the above remarks. The teaching in the subject in which I examine does not, in my opinion, attain so high a standard as it is desirable and practicable that it should. I have pointed out some special causes which have hindered its improvement, and I have also mentioned that it is improving.

3. I am of opinion that in so wide a subject as machine construction, the examination for which requires skill as well as knowledge, cramming may be prevented, if the examiner is sufficiently careful.

4. It is, no doubt, highly desirable that teachers of an important technical subject of this kind should have a higher training than is implied in the fact of their ability to pass the advanced stage examination. For example, it is important that all teachers of this subject should have some general knowledge of the strength and resistance of materials and structures. I have set, in the advanced stage, some questions involving elementary knowledge of this kind, but it is impossible, at present, to make the answering of these a condition of passing the examination.

5. The papers in machine construction, in the elementary and advanced stages, do not involve written answers. Hence I have formed no opinion on the point to which attention is directed in the fifth question of the Commissioners.

I have, &c.

W. CAWTHORNE UNWIN.

J. Norman Lockyer, Esq., F.R.S.

School of Military Engineering, Chatham,  
June 21, 1871.

SIR,

In reply to the questions in your letter of the 15th instant, I have the honor to state:—

1. I have only had two years' experience, 1870 and 1871, of the South Kensington System, and that only in one subject, building construction.

The opinion I formed, from the examination of 1870, is fully stated in my report to the Secretary, Science and Art Department, dated 7th June 1870.

That which I have formed from the examination of this year is stated in my report, which is now in the hands of the Secretary, Science and Art Department, for printing.

It will be seen from these reports that the opinion I formed last year, as to the knowledge of the students, and as to the teaching, was as unfavourable as it could possibly be, but that the improvement this year is very marked.

I think that there is reason to expect, for some years, great further improvement in the teaching, and, in that case, the effect can hardly fail to be to get rid of a number of inferior methods of construction in details, now used locally, and to bring into more general use those methods which are considered the best.

2. The teaching has this year improved much, and is in the right direction to give a practical knowledge of the subject, but there is room for great improvement, which may be attained by the more general use, by the teachers, of large diagrams and models.

I should say that such diagrams and models of the simpler details of construction are already supplied to some extent.

A special Text-book is also a great desideratum.

3. Taking "cram" to mean, that, by it, a student is enabled to give a correct answer, the meaning of which he does not understand, there is little opportunity for "cram" in this subject.

The examinations are almost entirely by drawing, and if a student can draw a detail of construction correctly, he must generally understand the construction itself.

4. None.

5. The papers being almost entirely drawing papers, no evidence is afforded on this point.

I have, &c.

HENRY WRAY,

Lt.-Col. R. E.

The Secretary,

Royal Commission on Science.

39 Ashburnham Grove, Greenwich, S.E.,

SIR,

June 22, 1871.

In compliance with your letter of the 15th inst., respecting the examination papers under the Department of Science and Art for 1871, I beg leave to state that I have thought over the several questions contained therein, and have now the honour to furnish the following answers:—

1. My opinion, as to the amount of good which is done by the South Kensington System, may be expressed as follows: it puts within the reach of young persons the means of acquiring technical education which they, if left to their own resources, could not obtain, and who would, probably, remain ignorant of fundamental principles and theories which, in after life, will be found to be most useful to them. It encourages industry, inasmuch as it induces them to devote their spare time to improving their minds, instead of wasting it in idleness. It suggests subjects for study adapted to the various tastes and circumstances of the students; and, upon the whole, it cannot fail to make them better artisans, and, consequently, better members of society. The examinations provoke a spirit of emulation among the students, and also stimulate them in their studies.

2. The evidence afforded as to the practical nature of the teaching is such as to lead to the supposition that the teachers are upon the whole qualified for their work; and the advanced papers, for instance, show that a decided improvement has taken place since the same candidates worked the elementary papers, thereby proving that a benefit has been conferred upon those who have received instruction in this manner.

3. With regard to the amount of "cram," and the power of testing it by examination, I may mention that the subject of naval architecture is so wide, and the questions that can be given are so numerous and varied, that unless the student has been fairly taught, he must inevitably fail at the examination.

4. The test afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher in naval architecture is, that he thereby displays a fair knowledge of practical shipbuilding, and shows that he understands the



principles of drawing to a scale, and the geometry of ship-building, or what is technically called "laying off."

5. No evidence, in my opinion, is afforded in the badly spelt and ungrammatical papers that they are, as a rule, the work of young persons.

I have, &c.

W. B. BASKCOMB,  
Examiner in Naval Architecture,  
Science and Art Department.

The Secretary,  
Royal Commission on Science,  
6, Old Palace Yard, S.W.

127, Harley Street, Cavendish Square,

June 21, 1871.

SIR,

I ENCLOSE a paper containing my replies to the questions you ask in your letter of the 15th June.

I am sorry to see that the drift of the questions indicates hostility to the scheme under which science teaching is now promoted. As, for some years, I was Principal of the Engineering College at Putney, the only attempt made in this country to give a good scientific practical education, I have for a long time had the subject before me, and I became convinced that it was hopeless to expect anything like an "École Polytechnique" in England, unless the Government would set it on foot.

If any plan is to be successful, it must *begin* by encouraging science teaching in a humble manner over a very wide area, so that those who have aptitude for such studies should be found out.

The next step is to provide for the higher scientific education in connexion with actual applications of theory, laboratories, and workshops, a forge or foundry, actual surveys, both superficial and geological.

Such a plan has been conceived and partly carried out. Its success was sufficient to show that it was necessary to have Government aid to perfect it, and the experiment was brought to a close by the difficulties which attended a project depending solely on private aid, chiefly that of the Duke of Buccleuch, and some others.

The Government has lately recognised the necessity of such a scheme for the civil engineering service of India.

In returning my answers to your questions, I may, perhaps, be permitted to add, that I hope the recommendations of the Commission will be for the improvement of existing means of encouraging science, and not for discouraging them; and I say this disinterestedly, for I must soon retire altogether from my work in the education of the country, and shall regret very much if, after labouring, more or less, for 30 years, I should not be able to discern real steps of progress in this subject.

There has been much talk about scientific education, some little advance to it: a noble encouragement by Sir Joseph Whitworth, the schemes of the Government in the School of Mines, the School of Naval Architecture, and, then, the more prominent place assigned to science in the older Universities and in the University of London. But the discovery of scientific aptitude in the labouring and middle classes is only provided for by the examination of the Science and Art Department, at South Kensington, which, if judiciously managed and *steadily continued*, will stimulate and bring out the great mass of latent force which must exist in our people.

The Secretary of the  
Royal Commission on Science.

I have, &c.

B. M. COWIE.

#### MATHEMATICS.

I. As to the general value of the South Kensington scheme, I think it has stimulated the desire to obtain scientific knowledge, and called into being the teachers who impart it. The amount of good will be greater or less according to the popularity of the teacher, and his judgment. All that the Department can do is, to secure proficiency in the subject which he professes to teach, but this will not secure the teaching faculty, nor the power to attract, nor the power of selecting proper students for the class. The examination itself shows the *result* of these qualities, as well as the scientific acquirements of the teacher.

There is very great difference in the three grades of the subject in which I examine.

Stage i. A very little acquaintance with algebra as far as a simple equation, geometry as far as it is contained in the first book of Euclid, and arithmetic, will secure a second class.

A great number of boys are sent in who know very little. As they do not pass, they merely give trouble which is of small consequence. Of those who do well (class i.), I generally should say that they have acquired some mathematical facility. Of those who pass in class ii., a fair proportion may be said to have some useful mathematical knowledge. A great many are not very satisfactory, but they get a class by marks, and ought not to be discouraged or rejected.

Stage ii. We require that those who pass should get fair marks in *two* subjects at least. No one can get a class by one subject only. The paper contains questions in algebra, geometry, and trigonometry. Too many take the paper only because they have passed the first stage, and fail. Still, speaking of those who pass in this stage, I am of opinion that they have made a good step in the subject.

Stage iii. These men, also, speaking of those who pass, and leaving out of the case those foolish candidates who know very little, and think it a fine thing to say that they took an advanced paper, show a very fair progress in mathematical knowledge.

Putting all this together, I think a very fair amount of good is done by the system. I think the grades i., ii., iii., in mathematics, are very fairly distinguished, and that progress from one to the other is real progress.

II. There are many teachers who know their business and teach well. There are some whose pupils show, by their papers, that they are not well taught. These we try to discourage. This year, one school was reported as showing, in the aggregate, that the teacher is incompetent, and it was recommended that no payments should be made.

The "practical nature of the teaching" is, however, a phrase which I hardly understand. In my subject, part is theory, part is practice. I think the theoretical questions, corresponding to what we called "book work" at Cambridge, are better answered than the questions which are of the nature of problem, rider, or example. I apprehend that this is a specimen of the universal experience of examiners, who would all tell the same tale.

We can hardly expect there will be many teachers who have the faculty of making thorough mathematicians. There is a natural gift of this kind which is rare; besides, the capacity of being made a mathematician is not universal either.

III. The amount of "cram" is considerable in some subjects, such as geometry and the introductory part of trigonometry.

In the former subject, it is an undoubted fact that *Euclid is learned by heart* in many schools. A question distinctly put in the words of Euclid can be answered by such scholars. It is not easy to check this. If an enunciation is changed, it is generally changed for the worse. We try to add to the demonstration of a proposition in the same question, some rider to which we give half the marks, because it determines whether the proposition has been understood as well as learned.

In trigonometry it is easily checked. The questions are so set that the crammed student is betrayed at once.

In mathematics it is tolerably easy to check "cram," when you get beyond the elements. It is always possible to set questions which are easy enough to the well-instructed student, and throw out the "crammed" completely.

IV. This is already answered under I. The fitness of the candidate to become a teacher is tested to this extent: you ascertain the acquirements of the teacher. The examination of his pupils gives us a measure of his capacity for teaching that which he knows.

The first qualification is sufficiently tested by his passing in the advanced papers, and if his employers wish for a higher test, a very efficient one is afforded by the honours paper.

V. There is no doubt that, in the elementary stages i., ii., the majority of candidates are very young, and often very ill educated; writing, spelling, and power of expression being in such cases defective. Sometimes we have to remark that such candidates would have been better employed in completing their elementary education. But, taking the examination generally, it is not true that the majority are too young or too ignorant of spelling, and certainly the successful students are not liable to any such imputation.

It is especially in Ireland that numbers of candidates are sent up, who are too young and too ignorant of spelling and composition. No particular harm is done, as they all "fail." This will correct itself in time, as teachers will not persevere in sending up pupils who fail.

B. M. COWIE.

June 21, 1871.



REPLY to QUESTIONS relating to the Examinations conducted by the Department of Science and Art, by T. Archer Hirst, Ph.D., F.R.S., formerly Professor of Mathematics in University College, London; now Assistant Registrar in the University of London, and Examiner in the Higher Pure Mathematics for the Department of Science and Art, South Kensington.

Question 1. "What opinion have you formed as to the amount of good which is done by the South Kensington system generally, and of the value of the examination in the different grades?"—I believe that the Science and Art Department are doing good service by promoting instruction in science, and by affording aid and encouragement towards the foundation and maintenance of science schools and classes throughout the country. The system of examinations they have instituted is comparable, in point of thoroughness and utility, with any now in existence. These examinations have revealed, and also increased, the desire for scientific instruction on the part of the middle and artisan classes, and they have, moreover, proved the necessity of supplementing the present action of the department by measures more directly calculated to raise the character and tone of the existing instruction in science. Under present circumstances, the practice of paying teachers according to the results of competitive examination is, perhaps, as good as could be devised for rendering teachers more painstaking; it does not, however, sufficiently secure good teaching. Competitive examinations, by means of papers which have to be worked under pressure of time, are, at best, but a very imperfect test of the soundness of the knowledge possessed by candidates, and of the training which they have received; and, as a consequence of this, we find that those who, in reality, are most successful in preparing candidates for such examinations do not rank amongst the best teachers, and frequently are not even good ones. They do not, as a rule, teach with that singleness of purpose which is so essential to sound education; the examination-value of their lessons occupies too prominent a place in their own thoughts, as well as in those of their pupils; the true objects of study are thereby overlooked, and a love for it checked rather than fostered. The extraordinary development given, in recent years, to the system of competitive examinations is, in fact, far from being an unmixed good. A deterioration in the quality of the instruction given accompanies the rapid increase in the number of those who receive it. To the universal struggle to score marks at competitive examinations, or, rather, to the habit of study which is engendered by the too exclusive preparation for this struggle, I am inclined to attribute most of the prevailing superficiality of scientific knowledge. The only remedy for this to which I look with any degree of hopefulness is the establishment of well-organised training schools for teachers,—schools wherein those who intend to devote themselves to teaching should not only have opportunities for extending and maturing their own knowledge, but also for exercising themselves in the art of teaching under the direction and inspection of the best masters of that art. The more frequent contact, too, with superior minds, which would be secured to him in such a school, would do more towards raising the *morale* of the teacher, and giving him a proper appreciation of his high vocation than, perhaps, any other measure that has been proposed. In my answer to question 4 I shall probably have occasion to return to this subject.

Question 2. "What is the evidence afforded as to the practical nature of the teaching?"—I am not sure that I correctly understand the bearing of this question on the examinations which I have had to conduct, and to which I prefer to limit my remarks. To me, the most practical teaching of pure mathematics is simply that which is most thorough and theoretically sound; that which seeks, above all things, to establish habits of accurate reasoning, which tolerates no shirking of difficulties, and no looseness or obscurity of expression; that, finally, which keeps mere manipulation, according to rule, in due subordination to a clear comprehension of the nature and origin of rules. Judged by this standard, the worked papers submitted to me at the South Kensington Examinations afford very little evidence, indeed, of teaching of a practical nature. For reasons before alluded to, I am quite prepared to admit that these papers may represent but very imperfectly the result of the teaching which their writers have received. Making all due allowance for this, however, evidence enough remains of the prevalence of mathematical teaching which is not practical, because it is not sufficiently sound and well grounded on principles.

Question 3. "What opinion have you formed as to the amount of 'cram,' and the power of testing it by examination?"—To some extent I have already answered this question. By "cram," in mathematics, I understand the loading of the memory with verbal answers to anticipated

questions, and with rules and demonstrations which the understanding has not fathomed. This vicious habit undoubtedly prevails to a deplorable degree. It is the natural offspring of competitive examination, the invariable resource of the incompetent and indolent, who covet, but do not deserve, the worldly advantages which success in examinations secures. Nothing is more easy than to detect "cram" in mathematics. A slight alteration in the enunciation of a theorem, or in the conditions of a problem, is in general quite sufficient to reveal its existence. What is here said, has reference, of course, to "cram" in its worst forms; it should not be forgotten, however, that it exists in all possible degrees, and that, in its milder forms, it loses much of its repulsive character, and becomes simply imperfect knowledge.

Question 4. "What test is afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher?"—No one whose studies have not extended far beyond the subject matter of the lessons he has to give, can properly teach the elements of any science. A teacher, therefore, ought to be able to pass an examination in the higher branches of the subject he professes to teach. This, however, is a very insufficient test, indeed, of his fitness to teach. Other qualities, moral and intellectual, are required in a teacher, the presence or absence of which written examinations cannot in the least reveal. This brings us again to the subject of the selection and training of teachers, touched upon in my answer to question 1. I am convinced that it is the question of most pressing importance in the present inquiry, and I trust that, through the intervention of the present Commission, more decided steps towards its solution will speedily be taken. I am aware that, at present, a certain number of teachers are yearly brought to London for the purpose of hearing lectures delivered by Professors Huxley, Frankland, and Guthrie, and of attending practical classes conducted under their superintendence. An extension of this practice, in the shape of a well-organized and supported training college for teachers of science, is now greatly needed. It is to such a college that we must chiefly look for the production of a class of teachers possessing wider culture, more matured knowledge, higher aims, and greater *savoir faire* than those upon whom candidates for competitive examinations are now, for the most part, dependent.

Question 5. "Whether any evidence is afforded, in the badly spelt and ungrammatical papers, that they are, as a rule, the work of young persons?"—Bad spelling and grammar do occasionally, but not very frequently, disfigure the worked papers which are submitted to me. The haste with which such papers are written sufficiently accounts for the fact, and, consequently, I attach but little importance thereto. The subject in which I examine being the higher mathematics solely, very young persons are necessarily excluded from competition.

#### MEMORANDUM in Answer to Questions proposed by the ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION.

1. The existence of the South Kensington System presupposes that there are persons who wish to acquire a knowledge of one or more branches of science. I have no doubt that the direct effect of the system is to induce those persons to pursue the studies in which they are interested with more system and thoroughness than they would do, at least in all ordinary cases, if left to themselves. It produces also, I suppose, the indirect effect of inducing many to study one or more branches of science, who would otherwise have paid no attention to such matters.

With regard to the value of the examinations I may remark, that, with a few exceptions, the successful candidates are arranged in two grades, and in two classes in each grade: four classes in all. There are two papers of questions, one for each grade. Speaking with reference to the subject in which I have acted as examiner, viz., theoretical mechanics, I may state, that those who get into the lower class of the lower grade have all given evidence of having acquired, at least, a real knowledge of the very elementary parts of the subject; those who stand high in the lower class, and those in the higher class must know the leading facts of the science, and be able to reason on them and to work examples in them. Those who pass in the advanced paper must have studied to some purpose as much of the science as can be treated without a knowledge of the differential calculus, while those who pass well in it give clear evidence of having thoroughly mastered the subject up to the point indicated.

The few exceptions mentioned above are those who pass in honours. In this part of the examination the questions asked are such as could only be answered by candidates having a very considerable knowledge of the subject, such, for instance, as might be possessed by a wrangler.



It may be well to add that the test applied is sufficiently strict to ensure the failure of a considerable proportion of the candidates in each grade.

The value of the examination, then, consists in this, that it supplies candidates with an obvious motive for mastering instead of playing with their subject, it enables them to judge of their success in their study, and, doubtless, in very many cases, it serves as an inducement to begin a study which would not otherwise have been taken in hand. In this view the value is very great.

(2.) If I rightly understand this question, I should say, speaking with reference to my own subject, that a person who has learned such matters as the properties of the centre of gravity, the relations between the forces acting on simple machines, the principles of rectilinear and circular motion, the pressure of fluids, the conditions of flotation, &c., has learned matters of a very practical nature. It is, however, to be borne in mind, that in most practical work the rules actually used are not the first principles with which science is conversant, but are secondary, and are derived in many cases from the principles of several sciences. Consequently, a knowledge of scientific principles would, in ordinary cases, be of little *direct* use to an artisan. The *indirect* use, however, would, I suppose, be very great, e.g. in cases which cannot fail to arise, when the accustomed rule has to be varied.

(3.) A candidate is said to "cram," I suppose, when, without understanding the matter, he commits to memory answers to particular questions which the examiner is thought likely to ask. I have observed very little, if any, work of this kind in the answers to my questions. In my opinion, an examiner, by carefully framing his questions, can, almost without fail, prevent any candidate from passing who trusts mainly to "cram," understood as above.

I may, perhaps, be allowed to state further, that I very much doubt whether, in any but the most exceptional cases, candidates could hope to pass by using their memories without their understandings. Thus, even if such simple questions are asked as "What is meant by the specific gravity of a solid or liquid?" or "State the three laws of motion," it rarely happens that the statements are quite satisfactory, except those made by the better class of candidates, showing, either, that no attempt has been made to commit such points to memory, or, else, that the memory has failed.

The case in which "cramming" may be occasionally resorted to with success is, I suppose, when a candidate has studied only part of his subject, and at the last moment gets up at hazard a proposition or two in the other parts which he does not know, on the chance of their being set; but, then, it will rarely happen that he will select the right propositions, and, even if he do, he will commonly fail to write them out correctly.

4. A candidate who passed *high* on the advanced paper might be safely set to teach candidates for the lower paper. I mean, of course, so far as his knowledge is concerned. Such a person, it may be added, will increase his own knowledge of the subject by teaching others.

5. A considerable number, but quite a minority, of the candidates show, by bad spelling and want of power of expressing their meaning, that they are comparatively uneducated. I suppose that these are, for the most part, young persons of the artisan class.

JOHN F. TWISDEN, M.A.  
Examiner in Theoretical Mechanics.

June 21, 1871.

Machinery Department, Royal Arsenal,

Sir,

July 13, 1871.

IN reply to your letter of the 15th June 1871, respecting certain questions with reference to the examination papers under the Department of Science and Art for 1871, I have the honour to furnish the following answers for the information of His Grace the Duke of Devonshire, and the Royal Commissioners on Science.

1st question. "What opinion have you formed as to the amount of good which is done by the South Kensington System generally, and the value of the examination in the different grades?"

I am decidedly of opinion that good is being done, probably not so much as may appear upon the surface, still it is a useful agency for disseminating real knowledge among a class of men where scarcely any knowledge existed before. In my official capacity I am constantly in want of men of a superior class for Turkey, who have not only to be good workmen themselves, but they require to be qualified to teach other men in a professional capacity. In selecting such teachers, I rarely find one who could answer the questions in the elementary papers, unless they happen to have been connected with these classes; workmen in general, and even good workmen, know next to nothing of

any mechanical subject which is not a part of their handicraft. Of course, there are many exceptions, but, as a rule, it is so, and no one has had a better opportunity than myself of finding this out, because, for a number of years past, I have been in search of such men; but I am led to hope that the efforts of South Kensington will gradually work a change for the better.

Another point is raised in this No. 1 question, namely, "the value of the examination in the different grades." This is a more difficult point to answer; at the same time, I do not see any better mode of ascertaining the result of the teaching than by the present system. If the examinations were left to local efforts, I fear that there would be a greater tendency to partiality than is the case at present. In my opinion, the questions are often fairly answered by some who have not acquired much of the real natural knowledge of the subject.

2nd question. "What is the evidence afforded as to the practical nature of the teaching?"

This is a most important question, referring to my own subject of Applied Mechanics. I am under the impression that some of the teachers have but little practical acquaintance with the subject, that they have derived their knowledge mostly, if not altogether, from books; this is wrong; it seems to me that the teachers should be men who have been applying mechanics *practically* for some time, and who, in addition, have acquired the book knowledge; the two sorts in combination are essential.

3d question. "What opinion have you formed as to the amount of 'cram,' and the power of testing it by examination?"

There is evidence of a good deal of "cram," but I do not see how it can be avoided under the circumstances, but "cram" is better than nothing, and when the good men leave the classes, it will be found that the good seed will bear fruit afterwards.

4th question. "What test is afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher?"

I have carefully considered this question, and, in my opinion, there is no evidence whatever that such men are qualified to become teachers.

5th question. "Whether any evidence is afforded, in the badly spelt and ungrammatical papers, that they are, as a rule, the work of young persons?"

The answers given in the papers are so varied, that no general inference can be drawn; there are some who can write and spell correctly, but have no real knowledge of the subject, while others show real knowledge who may spell very badly.

I have, &c.

JOHN ANDERSON, LL.D.

The Secretary, Examiner in Applied Mechanics.  
Royal Commission on Science.

Royal Institution, Albemarle Street,

Sir,

June 22, 1871.

THE results of the examination of 1871 had not reached me when your letter of the 15th arrived, but I am now in a position to answer the questions which the Duke of Devonshire and the Commission of which his Grace is chairman have done me the honour of submitting to me.

My relation to the South Kensington examinations is this:—I set all the examination papers, and organise a staff of gentlemen as assistant examiners. These are divided into two portions who respectively take charge of the two subdivisions of experimental physics comprised in the examination. Two principal assistant examiners are appointed, who take charge of the honours papers, and who also check and revise the other papers. With these two gentlemen I have been recently in communication regarding the questions which you have submitted to me.

1. In reply to the first question, I have to state that the two principal assistant examiners are decidedly of opinion that through the agency of such examinations as that just concluded, a great amount of sound scientific knowledge is diffused throughout the country. This, I may add, is the opinion which I formed of the effect of the examinations when I read the examination papers myself.

2. The second question is this: "What is the evidence afforded as to the practical nature of the teaching?" It is difficult to answer this question, the term "practical" is so eminently vague. If by it is meant teaching by aid of experiments and suitable apparatus, then the teaching must be defective in a great number of cases. The teachers in this country have never had any systematic training in practical experimentation. And although men may be found who become experimentists through the force of natural bent, it is not to be expected that teachers generally are of this class, or that they can dispense with practical



instruction. It is, therefore, an object to be aimed at, the founding of institutions in which teachers should be instructed in the use of apparatus sufficiently cheap, simple, and effectual, to be introduced with profit into class instruction.

I would here remark that although no scheme of education in physics is even approximately complete without illustrative experiments, an able teacher, even in the absence of apparatus, can do a great amount of good. It is possible, by the judicious use of the blackboard and chalk, and of simple models, to convey clear conceptions of various parts of physics, so clear, indeed, that, should the pupil afterwards witness the experiments, he shall witness that of which he had previously an accurate, though, it may be, an incomplete conception. Indeed, even where apparatus exists, the performance of experiments ought to go hand in hand with this diagrammatic exposition.

3. The third question has reference to the prevalence of "cram." This word I find differently interpreted, but I take the significance of the word to be knowledge, which bears some such relation to the mind as undigested food does to the body. This interpretation excludes the idea that all knowledge of experimental science, which does not embrace the experiments themselves, is necessarily "cram." For, as I said before, by proper descriptions, diagrams, and models, clear conceptions may be conveyed, and the mind of the pupil exercised in a salutary manner. On the other hand, I hold that pernicious "cram" may co-exist with the performance of experiments; for experiments may certainly be conducted in such a way as to address the senses without laying any real hold upon the intellect.

Judged by this standard, the amount of "cram" revealed in the recent examination is greater than it ought to be. Many teachers evidently set before themselves, as the main object of their efforts, the bettering of their own pecuniary estate; and a good number of them appear to entertain the notion that this end is more likely to be gained by increasing the number of candidates than by aiming at more excellent instruction. Of the 7,000 pupils recently examined in physics, many ought never to have appeared at all. Their incapacity must have been known to their teachers, provided the teachers themselves be not utterly incapable. Some method, I think, ought to be devised which should not only deprive such teachers of any advantages expected to arise from mere numbers, but which should also subject them to a definite penalty for the perfectly fruitless trouble and expense which they entail upon the Department of Science and Art.

The detection of "cram" must depend upon the sagacity of the examiner; a thorough insight of the working of the pupil's mind is here essential, and it is for this express reason that I have sought the co-operation of gentlemen experienced in teaching as well as distinguished in science.

4. With regard to the fitness of candidates to become teachers, it is no easy point to decide. Knowledge and teaching power are not necessarily the same. The latter implies the former, but the former does not imply the latter. Teaching power is, to some extent, a question of character, which is but imperfectly revealed by a written examination. Still, the chances undoubtedly are that the youth who expresses himself in writing with clearness and straightforwardness, will also prove efficient as a teacher.

5. I think the bad spelling may, for the most part, be traced to the more youthful candidates. Still, cases now and then arise in which knowledge, sound in quality and considerable in amount, is found associated with defective spelling. This defect, however, is a great nuisance, and ought to be stringently dealt with.

While commending much of the work accomplished by the teachers, and recognising, in this examination, many creditable results, I think it ought to be the aim of the Department to employ the less satisfactory returns with a view to lessening the incompetence or neglect which these returns imply.

I have, &c.

JOHN TYNDALL.

To the Secretary of the  
Royal Commission on Science.

Royal College of Chemistry,

June 21, 1871.

SIR,

IN reply to the queries which you have addressed to me at the request of his Grace the Duke of Devonshire, I have to state that—

First, I consider the South Kensington System of examination to be of great service in stimulating the teaching of experimental science throughout the country, and although much of that teaching is necessarily of an imperfect character, owing to the defective training of the

instructors, yet, on the whole, it contributes to the diffusion of scientific knowledge to probably a greater extent than is done by all the other means of scientific instruction put together. In my visits to various parts of the country, during the past three years, as one of Her Majesty's Commissioners for the Prevention of the Pollution of Rivers, I have been much impressed by finding science classes, in connexion with the Department, in many out-of-the-way places, where youths and working men, connected with mining and manufacturing industries, were receiving instruction. In most of these places the instruction could not be given without some such assistance as that afforded by the Science and Art Department.

With regard to the value of the examination in the different grades, I consider that, at present, the elementary and advanced stages are of the most importance, the honours stage having, as yet, in chemistry at least, attracted but few competitors. Persons coming up for the elementary examination appear to have been taught, for the most part, from books, or from lectures very imperfectly illustrated, but, during the past year, the instruction has become more practical, owing to the operation of the "laboratory grant" minute. Pupils attempting the advanced stage papers exhibit, in the examination just held, a much greater proficiency in experimental or practical knowledge than was the case in former years, and a large proportion of the papers in this stage are of a very satisfactory character.

Second. In the elementary stage, the evidence afforded as to the practical nature of the teaching is, as just mentioned, somewhat feeble, whilst in the advanced and honours stages it is strong and conclusive, proving that much sound practical instruction has been imparted to the candidates coming up in these stages.

Third. In preparing pupils for the elementary stage, there has undoubtedly been a good deal of "cramming;" but, in the early stages of instruction in science, there is always a considerable amount of information, such as laws, nomenclature, notation, &c., which must be acquired by mere effort of memory, as distinguished from observation and experiment, and I am, therefore, not disposed to look with utter disfavour upon a certain amount of what may be termed "cram" in the earlier stages of scientific instruction. Our whole system of literary and arithmetical education is so largely founded upon cram, that I fear we must not expect, for some time to come, so much attention to be paid to observation and experiment as is desirable.

Amongst the pupils attempting the advanced and honours papers, the evidence of cram is by no means wanting; nevertheless, they also give unmistakable evidence of a fair amount of knowledge acquired from observation and experiment.

There is but little difficulty in detecting "cram" in the chemical examination papers, and nothing would be easier than to frame all the questions so that "cram" would be entirely useless, or nearly so, to the candidate, but, for the reasons already given, I do not consider this desirable. A certain number of anti-cram questions are always set, and by the avoidance of these questions the crammed candidates are immediately recognised.

Fourth. I do not think that passing in the advanced papers is a sufficient guarantee of the fitness of a candidate to become a teacher. Nevertheless, at present, the choice lies between these men and others with still slighter qualifications.

Fifth. I do not think that badly spelt and ungrammatical papers afford conclusive evidence that they are the work of young persons, because I have repeatedly had letters from adult candidates exhibiting such defects; as, for instance, one I received on the 14th inst., from which I append some extracts.

I have, &c.,

E. FRANKLAND.

J. Norman Lockyer, Esq., F.R.S.

#### APPENDIX.

##### COPY OF LETTER FROM ADULT CANDIDATE.

I am sure you will pardon me, your most humble servant, for writing a few lines to you about the late examination in chemistry for the science and Art department of which you are the examiner, I your humble servant was one of the students that was examined at the Manchester Mechanic Institution, and I was informed yesterday the 12th that you have been so good as to give me a second class, well I most heartily thank you Sir, but still I should have been much better pleased had it been a first class, for I can assure you Sir I have been a student of chemistry for 4 or 5 years and I think that if the examination had been practical I should have been first, for I am a great lover of chemistry and by dint of management I have got a very nice Laboratory together though I have a very



large family of six children, I can assure you Sir that I have gone almost without dinner many a time so that I should have money to fit up my Laboratory with and buy a few old books on chemistry. for I have worked very hard at the science for some years. but Sir I happen to be one of those men who has had to work very hard from being a child and have got no Education as you will see by this and my examination papers. \* \* \* \* but I can assure you Sir I shall not give up the study for I love it and I shall make it my life's study. but I am sorrow to say that I do not think I shall every go in for another examination as I see I do not stand any chance on account of my want of Education. \* \* \* \* so hoping that you will not take this note amiss and that you will pardon me if I have said anything wrong as do not think I shall ever trouble you again as I see it is no use of me going in for examination as I do not think you have good data for judging who is the best man under the present system of examinations.

SIR,

Jermyn Street, June 17, 1871.

IN reply to the questions proposed, I have to state:—

1st. I think a considerable amount of good is done by the South Kensington System, and I approve of the different grades. The system necessarily gives the pupils an idea of the meaning and use of various branches of science which otherwise they would probably have no means of attaining.

2nd. The term practical is rather vague. If it means, in my branch, whether or not the pupils are taught practical geology in the field, I would say, that as a general rule, they are not. If it means whether or not they are well taught, I reply that most of the classes are fairly well, and some of them very well taught.

3rd. There is undoubtedly a considerable amount of "cram." I judge of this by the set phrases by which, in some classes, certain questions are answered. I have not, however, any means of judging, when such answers are correct, that the pupils do not understand the meaning of these answers.

4th. To the fourth question, there is no means of testing the fitness of a candidate to become a teacher, excepting the correctness and style of his answers. I make a point of valuing all such papers myself, and I observe that few of these candidates pass. Persons who "go in" for this office are often very ill qualified for it. It seems to me that often the fact that they are ignorant, and ill-educated, is the reason why they consider themselves likely to be qualified for the office of teachers.

5th. Undoubtedly bad spelling, bad writing, and bad grammar prove that many of the pupils are very young persons, and others, perhaps older, have been very ill educated.

In the annual reports sent to South Kensington, these circumstances are generally commented on by me.

From year to year there has, on the whole, been progressive improvement. This year the improvement has been very marked.

I have, &c.

ANDREW C. RAMSAY.

J. Norman Lockyer, Esq.

SIR,

Jermyn Street, June 23, 1871.

I HAVE the honour to reply to the questions put in your letter of the 15th inst. with reference to the examination of the South Kensington Department.

1. The results for 1871 go far to confirm the opinions which I expressed to the Royal Commission when examined in 1870 (2290-2298). I believe that much good has resulted in the mining districts, where the subjects of mineralogy and the principles of mining form legitimate matter for study; but a sorry exhibition of unsuccessful "cram" has been produced by candidates from certain localities, and especially by a large proportion of those who have competed for "scholarships" and "exhibitions."

Of the different grades, the "elementary" has generally been the best in its results; the "advanced" has done very well in mineralogy, but in the paper on mining it has in only a few instances been very good, though, as it seems to me, nevertheless, valuable from its fostering habits of observation. The "honours" grade has with me been a total failure, and is, I think, for several reasons undesirable to maintain.

2. The evidence, as to the teaching, is, I think, that for the elementary grade it has, as a rule, been good. In the "advanced" papers I have had, on the one hand, more guessing, on the other, very good results of personal experience brought before me.

3. To some extent the system of "cram" must be endorsed in this and other written examinations, but I believe that so far, with the exception of candidates eager to amass marks for "scholarships," it has not been excessive.

4. The passing in the advanced papers is, to my mind, but an insufficient test of fitness to become a teacher. Terse-ness, sufficiency of information, and facility in drawing the requisite diagrams, come out distinctly in the papers, but either the presence or absence of some of these qualifications might be greatly made up for by other qualities, to judge of which personal knowledge would be needed.

5. The bad spelling and ungrammatical language of some of the papers are in most cases the simple result, with young persons, of a very insufficient amount of common schooling. The sound is often accurately followed, as when a candidate described ventilating "operations with a current of air." Sometimes it results apparently from false reading, as a man referring to nitro-glycerine as a "viscous liquid." Most of the bad spelling has been associated with the poorest papers. But, on the whole, the answers have been better in these respects than might have been expected.

The numbers for 1871 have been as follow:—

Mineralogy.			Principles of Mining.		
Elementary—1st class	-	17	-	-	1
" 2nd class	-	9	-	-	11
" not passed	-	10	-	-	15
Advanced 1st class	-	2	-	-	1
" 2nd class	-	7	-	-	16
" not passed	-	2	-	-	8
Honours	-	0	not passed	-	2

I have, &c.

WARINGTON W. SMYTH.

SIR,

IN reply to your letter of the 15th June 1871, I beg leave to submit the following answers to the questions which it contains, which have been furnished, at my request, by two of the gentlemen (Dr. Rutherford, Professor of Physiology in King's College, and Dr. Foster, Prælector in Physiology in Trinity College Cambridge, and Examiner in Physiology and Comparative Anatomy in the University of London), who assisted me in the examinations of this and last year:

"Question 2. The papers do not afford any strong evidence of the teaching having been practical. Occasionally, and, perhaps, more especially in the papers of this year, the answers show that the candidate has actually seen the things which he describes; but, as a whole, the teaching must still be regarded as chiefly bookwork.

"Question 3. There is abundant evidence, every year, of cramming. There are certain kinds of gross cramming (when, for instance, answers to questions thought likely to be put are committed to memory, and when, therefore, the same answers will be given almost *verbatim* by all the members of one class) which can very easily be detected and punished. It is possible, by judicious framing of the questions, to defeat attempts at cramming, to a considerable extent. But it is probable that in this, as in all other examinations, a very large amount of cramming will go on in spite of all efforts to prevent it.

"Question 5. Every year it is apparent, from the style of the handwriting and from the character of the answers, that a very large number of the papers sent in are worked by very young persons, in fact, by mere children.

"Question 4. No written examination can ever be an adequate test of fitness to become a teacher. At the very best, a written examination can be no more than a means whereby to judge a candidate's general knowledge of the subject; but, so far as a written examination is a test at all, the advanced paper in Physiology affords a fair test whether candidates do or do not possess a sound knowledge of the elements of the subject.

"Question 1. Making full allowance, in all these unsatisfactory aspects of the examinations, we are still strongly of opinion that the good which is being done by them is very great. The answers in the elementary stage clearly prove that hundreds of young persons are annually becoming acquainted, if not in a wholly practical, yet in a fairly sound manner, with the elementary facts and principles of Physiology."

The answers in the advanced stage show, as distinctly, that a large number of young artisans and other young persons in a similar station of life are yearly acquiring very considerable physiological knowledge. The answers in this class are, perhaps, on the whole, superior to such as would be given by an average medical student, and the



best are above the standard required for the first M.B. pass at the University of London.

I have only to add, that I entirely concur in the opinions of Dr. Foster and Dr. Rutherford.

I am, &c.,  
T. H. HUXLEY.

MY LORD DUKE,

June 29, 1871.

As I have only this morning completed my examination of the answers to the Metallurgical questions of the Department of Science and Art for 1871, it was not possible to send an earlier reply to the letter addressed to me at the desire of your Grace, dated June 15th. I proceed to reply to the questions contained in that letter as follows:—

1. On the whole my opinion is favourable.
2. This question is somewhat ambiguous, as I do not correctly understand what is meant by "the practical nature of the teaching," in reference to the exposition of the principles of a manufacturing art, such as metallurgy. If it means whether the teachers employed by the Department have shown practical acquaintance with metallurgy, so far as may be inferred from the character of the answers of their pupils, I should say that, while some appear to be pretty well informed, others appear to be quite the reverse. I have noticed special blunders, stated in almost the same words, in many of the papers.

3. I am of opinion that there is a large amount of "cram," and *bad* cram, too.

4. I hold that the qualifications suitable for an efficient teacher cannot be decided, in any case, from the examination papers of students. Personal qualifications are, in my judgment, as essential to success as intellectual ones. I certainly would not venture to rely upon the evidence afforded by the "advanced papers," in judging of the qualifications of a teacher intended for an advanced class.

5. "The badly spelt and ungrammatical papers," on my subject, seem to be the work mainly of uneducated artisans.

I have, &c.

JOHN PERCY.

His Grace the Duke of Devonshire, K.G.,

&c. &c. &c.

SIR,

June 20, 1871.

IN reply to your letter of the 15th inst., asking me to answer certain questions with reference to the examination papers under the Department of Science and Art for 1871, I have to state:—

1. My experience is limited, as the subjects in which I examine are among the least popular, and are taken up by comparatively few candidates: 227 in navigation, and 87 in nautical astronomy. Since the system has been in operation I have remarked a great improvement in the quality of the answers, and at the last examination there were few which betrayed great ignorance, and were, for the most part, confined to those which were worked not by regular pupils of instructors recognised by the Department, but by apparently self-taught persons who were candidates for prizes and medals. I should certainly say that the system of examination by the Department of Science and Art is the only incentive in this country to the study of navigation and nautical astronomy *theoretically* as well as *practically*, all other examinations embracing the practical part only. The different grades operate in rendering the instruction sounder, by giving a strong inducement to the teachers to give more time and attention to the principles than they would otherwise give. I have no doubt, that much of the improvement I observe in the papers examined by me arises from the Department requiring every candidate to pass in the elementary grade before attempting the more advanced.

2. My questions are half theoretical and half practical, and it would be difficult to say which are, on the whole, better answered. Certainly I have no reason to complain that the practical work is neglected, perhaps in these subjects, which I presume are taken up by persons about to embrace a seafaring life, the practical work, which will also tell in the Board of Trade examination, would naturally be that which would tend to occupy most attention, almost to engross it, if means were not taken to prevent it. This was certainly the tendency several years ago, but, judging from the last papers, this is now corrected.

3. Several years ago, there were great attempts to "cram" the candidates, but this is difficult in such subjects as I examine in, in which a want of grounding is sure to betray itself, and I have no reason to suspect much attempt at "cramming" now.

4. No examination will or can be made a test of the fitness of a man to teach, but, short of that aptness, which

can only be tested by experience, I think that a man who obtains a first class in the advanced grade shows that he possesses sufficient knowledge to teach, if he also possesses the aptitude: in the same way that a wranglership or first class at the Universities tests only the knowledge, but not the teaching power of the person to whom it is awarded.

There can be no doubt that some of the teachers of the youths whose papers I examine are excellent instructors, wherever they have acquired their knowledge and skill.

5. As my subjects, especially nautical astronomy, require a fair previous knowledge of some branches of mathematics, I should not expect very young boys to attempt them. I have known cases, in former years, when boys of 11 and 12 have been presented for examination, but these were, almost without exception, failures. I have reason to believe, from internal evidence, that the papers worked by the majority of the students at the regular schools, are the papers of lads of 13 or 14. There is plenty of mis-spelling and crudeness and bad arrangement, mixed, for the most part, in real and genuine knowledge. I have said that there is a numerous class of evidently older candidates who do not profess to be regular students, whose passing involves no payment to teachers, who are merely candidates for prizes or medals. Their work is, for the most part, conspicuous by its incompleteness and betraying a want of grounding; a great proportion of the failures this year has been in this class.

I am, &c.

JOSEPH WOOLLEY.

J. Norman Lockyer, Esq., F.R.S.

Royal School of Mines,

June 23, 1871.

SIR,

IN reply to your letter I beg to submit the following answers:—

1. I have formed the opinion that the South Kensington System of Examination has been of the greatest value in advancing general education. The recurrence of authoritative examinations has stimulated both teachers and their pupils as nothing else would have done, and I am convinced that the influence of the examiners has wonderfully extended the spread of scientific information.

2. The papers enable the examiner to discriminate pretty accurately between the good and bad teachers. I consider that the examinations have already improved the instruction by rendering it more practical.

3. In the subject in which I examine it is not possible to cram with any success.

If examiners were more careful in framing their questions, I believe that the danger of giving high marks to those who have not shown any power of reasoning, and who are merely crammed for examination, would be quite inconsiderable.

4. I consider that the list of marks affords an imperfect test of the fitness of the candidate to become a teacher, but I am sure that an examiner can form a reliable judgment upon the probable merit of the candidate, by observing the style and method of his answers. I have often noticed evidence of the greatest clearness of thought and expression in papers which have not obtained the highest marks.

5. I am unable to reply to this question. I have met with some candidates entirely unfit for examination, and with others who were evidently good mechanics, though not competent to express themselves grammatically, or to write correctly.

I have, &c.

J. Norman Lockyer, Esq.

T. M. GOODEVE.

SIR,

33 Brunswick Square, June 1871.

To the communication I have had the honour to receive from you at the instance of Her Majesty's Commissioners on Science, I beg to reply as follows:—

In the subject of physical geography, of which I have been one of the examiners in the Department of Science and Art since 1867, and have held five examinations, the number of candidates has increased steadily and very rapidly, and in the present year amounted to 8,800. The subject being one that had not been taught in ordinary schools, but which is certainly very valuable, as including many facts of general interest and involving sound and philosophical deductions, and a fair exercise of the reasoning powers, is, perhaps, exceptionally adapted to illustrate the advantage or disadvantage of the South Kensington System.



A large number of the schools under the Department of Science and Art seem to be adapted for young persons. At any rate, a large proportion of the candidates for examination has always consisted of young students, many of them very little acquainted with the use of language, and very little or very badly taught in the common rudiments of education. In many cases the spelling and writing are exceedingly bad, and a certain per-centage of the candidates has been rejected at once as not deserving a single mark. This per-centage has decidedly diminished, while the number of candidates has largely increased each successive year.

The arrangement of the candidates into classes has been changed from time to time, but since 1867 there have always been two papers, and since 1869 a third or honours paper. At first the work done for the advanced paper indicated little more knowledge and no more teaching than that for the easy paper, and the result was that very few candidates passed the examination. The standard for this paper has, notwithstanding, been steadily raised, and in spite of this the per-centage of candidates has been increased. It is intended that none, or at any rate very few candidates from science schools, should attempt the advanced paper without having already passed in the easy paper at a former examination. I have always endeavoured to make sure that no one should pass in the advanced paper without at least as much accurate knowledge as would secure a first class in the easy paper. I find, however, that the per-centage of passes in the advanced paper as well as of first classes in the easy paper is increasing.

To obtain a first class in the advanced paper, which would be equivalent to a certificate as to fitness for teaching, I require in all cases some really good answers, and the absence of any gross error throughout the paper.

1. As a general reply to your first inquiry, I may say that whereas a few years ago the subject of physical geography had not entered into general education, and was hardly recognised in schools for the middle classes, there have been this year nearly 9,000 candidates for examination from the science schools, of whom at least one half have at any rate some producible knowledge of the subject, while probably 20 per cent. (say 1,800 young persons, many of whom propose to be themselves teachers) are really fairly instructed in the elements of physical geography, and may be supposed to take a certain amount of reasonable interest in it as a science, and will be in a position to follow it up if occasion requires.

2. The best evidence of the practical nature of teaching is to be found in the general intelligence indicated in the answers, as contrasted with the mere repetition of a form of words taught from a book. On the whole, I think, there is an improvement in this respect, but I am inclined to suspect that the style of teaching is generally bad, or, at least,

unsatisfactory, and that few teachers have learnt how to teach. Beyond all doubt there are many schools in which the teacher has no clear and distinct knowledge of the subjects he professes to teach, and in many cases the instruction in physical geography evidently has not been preceded by any instruction in the elements of descriptive geography. In the examination of this year, a large number of candidates had no clear notion of the meaning of latitude and longitude.

3. That the mere learning a subject by rote and having the faculty of answering questions correctly without any exercise of the intellectual faculties is very common, and is to some extent fostered by the examination system, there can be no doubt. It is not very difficult to test it by examination, but very difficult, indeed, to award to it its proper value. But the memory must be stored by facts, before the judgment is matured, and it is not easy to say where this system should stop. The intelligence of the teacher is really the only safeguard against the evil effects of "cram," as thus limited.

4. I have already pointed out that the nature of the advanced paper, and the amount and kind of information required to pass in the first class, afford reasonable grounds for granting a certificate that shall justify teaching. At the same time, it is certain that some may slip through who are not really fit, on account of the difficulty of determining, where no mistake is made, how much of an answer given is really understood. Even among the candidates for honours, a considerable number are only able to answer questions by rote, but in such cases they are never classed, although some may be allowed to pass. The result of the honours examination certainly shows an increasing number of students who really distinguish themselves, and will probably become admirable teachers.

5. In my remarks at the commencement of this letter, I have pointed out that a large number, but not I believe an increasing per-centage of the candidates, may be concluded to be very young, from the style of writing, the badness of the spelling, and the ignorance of grammar. At the same time, it is very difficult to judge, from appearances, whether these faults arise from actual youth, or whether they are due to the slowness with which elementary education is attained by grown-up persons who have been entirely neglected in this matter when young.

In conclusion, allow me to say, that I shall be most happy to give any information in my power to the Commissioners, and that I regret having been prevented by pressing engagements from giving evidence on a former occasion.

I have, &c.

D. T. ANSTED.

J. Norman Lockyer, Esq.

## APPENDIX XVIII.

### COMPARISON of the FEES of STUDENTS and the PAYMENTS on RESULTS in SCIENCE SCHOOLS under the Science and Art Department.

The following table gives the total amount paid to Teachers on results, the total amount of fees, and the proportion of fees to each *l.* of State payments on results.

	Fees.	Payments.	Amount of Fees to <i>l.</i> of Payments.
	£	£	£ s. d.
England and Wales - - -	3,588	12,694	0 5 7½
Scotland - - - -	795	987	0 16 1½
Ireland - - - -	329	5,187	0 1 3½

J. F. D. DONNELLY,  
Capt. R.E.  
29 Nov. 1871.



## APPENDIX XIX.

MINUTE of the LORDS of the COMMITTEE of the PRIVY COUNCIL ON EDUCATION on the INSTRUCTION given in the SCHOOLS OF SCIENCE receiving aid from the Science and Art Department.

Science Form, No. 466.  
South Kensington, November 1871.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

At South Kensington the 24th day of November 1871.

By the Right Honourable the Lords of the Committee of Her Majesty's most Honourable Privy Council on Education.

My Lords consider the question of the instruction given in the Schools of Science receiving aid from the Science and Art Department.

2. It appears desirable that the instruction of Students in Science, after they have completed the course of the ordinary Elementary School, should be carried on more methodically than is at present the case, and that they should not attempt to grapple with the more advanced forms of Science until they have received sound and practical instruction in those subjects which constitute the groundwork of all the Physical Sciences.

3. To this end, the course of instruction specified below has been prepared as adapted both to Secondary Day Schools and to Night Classes.

4. It will depend on circumstances, especially if the student can only attend Night Classes, how many subjects he can take up in one year. It must, therefore, be understood that the course should not only comprise the subjects named below, but also that they should be taken in the order in which they are stated.

5. The terminology used is that of the Science and the Art Directories. The Syllabus of subjects there given states precisely what is included under each head. And it is assumed that, before commencing the following course, the student will have been made acquainted, in the Elementary School, with the elements of Arithmetic, and the primary conceptions of Physical Science.

## COURSE OF INSTRUCTION.

*First Year.*

Mathematics (Subject V. First Stage).  
Freehand Drawing (2nd Grade Art).  
Practical Plane Geometry (2nd Grade Art).  
Elementary Mechanics, including the physical property of liquids and gases (Subject VI. First Stage).  
Physics: Acoustics, Light and Heat (Subject VIII. First Stage).

*Second Year.*

Chemistry, Inorganic (Subject X. First Stage), with practical work.

Physics: Magnetism and Electricity, frictional and voltaic (Subject IX. First Stage).

Mathematics (Second Stage and (if possible) Fourth Stage, Subject V.)

Practical Geometry (Plane and Solid), Subject I. First Stage).

Animal Physiology (if possible) (Subject XIV. First Stage).

The student should also, during the first and second year, work at Mechanical Drawing as provided for in the Art Directory, Stage 23a.

*Third Year.*

The work of this year must depend so much on the student's aptitude, and the progress he has made in the preceding course, that it is impossible to lay down the subjects for the third year's course with any definiteness. It is essential that before continuing his course, or commencing new subjects, he should have a sound knowledge of the first stage of Mathematics, Elementary Mechanics, Physics, and Chemistry; that he should have such a knowledge of Practical Geometry and Mechanical Drawing as to be able to draw and read simple plans, elevations, and sections with readiness, and that he should have sufficient facility in Freehand Drawing to make clear and neat explanatory diagrams.

6. When these subjects have been mastered, the student should, while continuing his studies in Mathematics, take up the first stage of Animal Physiology, if he has not already done so. He will then be in a position to specialise his studies with advantage in one of the following groups according to his requirements, taking up, for instance,—

1. Physics and Chemistry and Metallurgy.
2. Theoretical and Applied Mechanics, Steam, and Machine Construction and Drawing.
3. Theoretical and Applied Mechanics, and Building Construction and Drawing.
4. Biology.
5. Geology, Physical Geography, Mineralogy, and Mining.

The student may also with advantage continue his Freehand Drawing and Practical Geometry.

N.B.—The foregoing course is framed to lay the foundation of a thorough and systematic scientific training. It must however be understood that this course, though strongly recommended for all those who can devote sufficient time to go through it, in no way supersedes or does away with the power of holding special classes in different subjects for those who have not these opportunities, of diminishes the aid at present offered to such classes.

The fact of the course being intended as a systematic training will also explain the omission of certain subjects which are not to be considered unimportant because they find no place in the course. Thus, Systematic Botany will be found of very great use as a preliminary to the study of Natural Science. As such, it may be taught in Elementary Schools before this course is commenced. But further than that, it cannot be considered a step in a systematic course till the student takes it up as a portion of Biology in his third year. In the same way, Physical Geography is a subject which may with great advantage be studied in all schools, and is especially adapted for students who cannot go through a systematic course. The first elements of Physical Geography, treating broadly the outlines of Physical Science and describing its objects, should, as stated above, be taught as an introduction to its systematic study. But, Physical Geography in its general sense covers so wide a field, embracing to a greater or less degree so many branches of science, that it does not fall into a systematic course of training in science, though as a means of imparting highly valuable general information, as distinct from a systematic training, it may be strongly recommended.

7. With a view of aiding and encouraging Schools organized to give the foregoing courses of instruction, the following payments will be made irrespective of the general payments offered under the Science Directory.

8. In day schools, 10s. on account of each pupil who attends the full course of instruction, is present during 250 attendances of the school, and passes in one of the subjects of study laid down for his year.

9. Provided that, (1) the time table of the school is in accordance with the foregoing Minute and has been approved by the Department; (2) not more than two attendances are counted in one day; and (3) payment is not made on account of the same pupil for more than three years.

10. In night schools, 5s. on account of each pupil who attends the full course of instruction, is present during 75 attendances of the school, and passes in one of the subjects of study laid down for his year.

11. Provided that, (1) the time table of the school is in accordance with the foregoing Minute and has been approved by the Department; (2) not more than one attendance is counted on one evening; and (3) payment is not made on account of the same pupil for more than three years.

12. The school claiming this aid must be properly organized as a Science School. The grants cannot be claimed on account of classes held in a school already receiving State aid from the Education Department, Whitehall or the Commissioners of National Education, Ireland.

By order,

HENRY COLLE, Secretary.







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**ANALYSES OF EVIDENCE.**

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NOTES OF THE EDITOR



# ANALYSES OF THE EVIDENCE

## NOW REPORTED ON.

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**COLE, HENRY, Esq., C.B.** (Index of his Evidence.)

*Aberdeen, Lord.*

The time has come for carrying out recommendation of his Government respecting a science college, 5954.  
Change of Department of Practical Art into Department of Science and Art under, 2.

*Accommodation for Science Purposes.*

Great want of, in Jermyn Street institution. Demand for more accommodation from Sir R. Murchison now before Office of Works, 5985.

Amount of, required for teaching in proposed new buildings at South Kensington, 5987-5991.

*Apparatus for Science Purposes.*

Providing apparatus and conveniences one of the means by which State aid should be applied, 240.

*Applied Mechanics.*

Estimate of expense for teaching, in proposed science college; professor in, proposed, 5953.

*Art Examiners.* See *Examiners.*

*Artizans.*

Moderate fees paid by, for science classes, 2.

Teaching in science to, throughout the country, chiefly conducted in evening classes, 171, 172.

Difficulty in defining who are artizans, 233.

Payments from, not remunerative to art masters, 5954.

Probability of future State aid not being confined to, 5955.

Fees for science instruction only just beginning to be paid by, 5960.

*Art Schools.*

A few masters purposely trained for, have become distinguished as painters; no good would have arisen from making those guarantee that they would remain teachers, 5979.

Former and present practice as to admission of pupils, and bringing students from the country, and maintaining them by weekly allowances, 6009, 6020.

*Art Teachers.*

Art masters could not exist upon fees paid by artizans, 5954.

Seldom stay till they have taken the six certificates for thorough training; the same may be prognosticated of science teachers, 6075. Much depends on the requirements of the district from which a student comes; no hard lines of definition can be laid down as to length of a man's stay, 6076.

See also *Science Teachers. Teachers (generally).*

*Art Training School.*

Its experience and analogy useful in a training school for science teachers, 44.

*Ayrton, Mr.*

Is now responsible for the new buildings at South Kensington, 64-67.

*Berlin.*

Comparison of laboratory at, with that of Dr. Frankland, 47.

*Biology.*

Estimate of expense for teaching, in proposed science college, 5953.

Professor and demonstrators in, proposed, 6000.

*Bonn.*

Laboratory at, comparison of, with that of Dr. Frankland, 47.

*Botany.*

Amount paid by State in 1867-8, in aid of, 115.

Estimate for demonstrator in proposed college of science, 6000.

*Building Grants.*

Estimate for, for 1870-71, 7, 10.

Likely to increase, 11.

A place manifesting its earnestness for science teaching like Owens College is fairly entitled to a building grant, 125.

**COLE, HENRY—Building Grants—cont.**

Very few, for the erection of scientific day schools, 192.

Grants for buildings, laboratories, apparatus, and diagrams advocated, 233.

One of the means by which State aid should be applied, 240.

*Carpenters and Joiners.*

In 1852 it was not purposed to teach geometry to, 6085.

*Central Science School.*

The proposed creation of, at present exists only verbally, 2.

*Certificated Masters.*

Employment of, as teachers of evening classes of science only transitional, 183.

*Chemistry.*

Amount paid by State for encouragement of, in 1867-8, in London and Scotland, 115.

State aid to, would be best applied by increased facilities and apparatus, 232.

Encouraged nominally for the benefit of artizans, should be encouraged for general good, without restriction to any class, 233.

Estimate of expense for teaching in proposed science college, and for demonstrators, 5953.

Professor of, should see that his pupils were competent to impart instruction, 5967.

Good accommodation for teaching, in new buildings at Kensington, 5986.

If future teachers in chemistry are required to undergo a preliminary study before entering the proposed training college to learn how to teach, it is fitting that they be maintained while going through the latter operation, 6005, 6006.

"Elementary," when applied to, needs definition, 6042.

The space assigned to chemical laboratories in the new building might be utilized for other purposes, 6043, 6044.

The present laboratory space was planned to answer the demand of science teachers, who are increasingly desirous to come, and also of the public students, 6044.

*Civil Engineering.* See *Mechanics and Civil Engineering.*

*College of Chemistry.* See *Metropolitan College of Science (proposed). Royal College of Chemistry.*

*Collusion.*

Between students, and between students and teachers, 35-37.

*Committees, Local.* See *Local Committees.*

*Competition.*

Persons receiving State aid have a distinct advantage over private competition, 116.

There is no reason why the State should not endeavour

to supplement deficiencies of private teaching, 118.

Class schools and restricted schools have no right to complain of State general schools; the result—science—is what is needed, 119-121.

There should be none, 126.

Would be obviated by turning all regius chairs into public scholarships, applicable to persons passing out of private bodies, 127-129.

With existing institutions not anticipated under the proposed training college, 249.

For entrance into the training college should be as fair as could be devised, 6033.

*Cramming.*

Tendency of some teachers towards; decrease of the practice; the worst cases of cramming occurred under teachers supposed to be highly skilled, 156-164.

*Dean.*

A dean should be elected, or rotated, to preside over the council of professors, in scheme of proposed science college, 5953.



## COLE, HENRY—cont.

*Demonstrators.*

Estimate of remuneration, &c. of, in proposed science college, 5953.

*Department of Practical Art.*

Change of, into Department of Science and Art, under Lord Aberdeen's government, 2.

*Department of Science and Art.* See *Science and Art Department.**Donnelly, Captain, R.E.*

Evidence of, in 1868, referred to, 2.

His arrangement as to the printing of examination papers, 218.

Estimate of annual expense of training college for science teachers prepared by 5953.

His system of inspection of science examinations by engineer officers, 5973.

His suggestion that if a guarantee be exacted from science teachers in return for training, there would be an obligation to find them employment, 5980.

*Earnings.*

Of teachers of science, 139–141.

Art masters could not exist upon fees paid by artizans, 5954.

*Education.*

The laws of political economy do not apply to education; if the public requires teachers in science it must pay for their creation, hence the necessity for the proposed training college, 6007, 6008, 6012–6019.

*Education Department.*

One system of graduated inspection for elementary and other schools might be developed under supreme authority of, 5974–5976.

*Education in Science.*

Scientific instruction first systematised in 1853, 2.

State aid is necessary if more science be introduced into the instruction of the country, and should take the shape of encouragement to local efforts rather than of arbitrary action, 114.

Amount paid in 1867–8 for encouragement of science in London and Scotland, 115.

*Elementary Education.*

Experience in, has shown necessity of particular instruction in art of teaching, 6003.

Should certainly not be taught in the proposed College of Chemistry; some qualification in students must be required, 6010.

Not contemplated in the proposed training college, 6040–6042.

*Elementary Schools.*

Science schools have been held in, during the night, 12.

Necessity of a separate grade of, 5955.

Employment for science teachers in, 5956, 5957.

A science teacher might give instruction in, in the day-time, and also teach science elsewhere in the evening, 5965, 5966.

Might be embraced in one system of graduated inspection, under supreme authority of Education Department, 5974–5976.

*Elementary Teachers.*

Ordinary elementary schoolmasters should not be forbidden to teach science in the evening, but a better system is necessary, 5966.

Science teachers need not be necessarily elementary teachers in schools; persons qualifying themselves as such might be admitted as science teachers under various conditions, 6025, 6026.

See also *Science Teachers. Teachers (generally).*

*Endowed Schools.*

Certainty of science teachers being required in, 5958.

Require to be looked after, 5976.

*Engineer Officers.*

Services of, in visiting science schools, 7, 8, 5973.

*Estimates.*

For the purposes of science, science schools, &c., for year 1870–71, 7, 10, 11, 13.

Under the present system must largely increase, 143.

For payments on results to teachers, at present, 24,000*l.*, 144.

Estimate of annual expense of a training college for science teachers, prepared by Captain Donnelly, 5953.

The estimates of 66,000*l.* and 45,000*l.* respectively include all fittings; there is no reason to believe the expenditure will exceed the estimate, 6065–6070.

## COLE, HENRY—cont.

*Evening Classes.*

By the system of payment on results, especially in night classes, the estimated vote may be raised exceedingly in few years, 149.

A science teacher could give instruction in, as well as in day classes, without being overworked, 5965.

Masters of elementary schools should not be forbidden to teach science in the evening, but a better system is necessary, 5966.

*Evidence.*

Before H. C. Committee in 1868, especially of witness and Captain Donnelly, referred to for account of Science and Art Department, 2.

*Examination Papers.*

Number worked in 1868 and 1869, 6.

Payment for preparation of, 7, 13.

Number of papers passed by examiner test of ability of teacher, 17.

Of pupils so nearly identical as to prove communication, 36, 37.

Examination papers are preserved generally for about a year, 211.

Mode of giving out, collection, inspection, and passing of students' examination papers; are examined in London only, 216.

Care taken to prevent surreptitious procurement of examination papers; Capt. Donnelly's arrangement for printing them, 218, 219.

The number of, determines the remuneration of the examiners, 239.

Inspectors should be required to do some work irrespective of paper examinations, 5973.

See also *Examinations. Examiners.*

*Examinations.*

In local science schools, how conducted, 2.

Payments on results of, 2.

In science schools, of higher character now than when system first established, 4.

Details of science school examinations in May 1868 and 1869, 6.

Estimate for preparation of papers for examination for year 1870–71, 7.

Number of, for each school, annually, 8, 9.

A teacher must have passed examination, or he would get no payment, 16. No qualification except having passed required for teachers, 26.

Former and present, of teachers, 27–32.

No check at present on sending up persons to be examined, 142.

Rate of increase in number of persons examined in science in 10 years, 146.

Per-centage of rejections last year rather more than one third, 151.

The system of, prevents copying, and such like faults, 154.

Tendency to "cram" for; decrease in the practice; new teachers commence the system, but after experience find it does not answer; the old system of, for teachers, a check upon cramming only so far as proving the teacher's knowledge; some of the worst cases occurred under teachers supposed to be highly skilled in teaching, 156–164.

No vivâ voce examinations are practised, but the power to hold such is reserved, in case of necessity, 217.

Under proposed central system will be more strict than at present, 234, 235.

For admission into proposed training college should be subject to as fair competition as could be devised, 6033.

Teachers will be examined at conclusion of course of training, with probably some recognition of results; no intention to make their examination at large more stringent than at present, 6057–6058*a*.

*Examiners.*

The fact of examiners doing their duty, and the inspection, the only guarantees that the money voted is spent properly, 150, 155.

If there were reason to suppose an examiner in science or art did not do his duty properly, he would not be asked to do his work again, 169. The duty is not a permanent arrangement, 170.

Send in reports to the Department, the number of marks, and sometimes special reports; they confer together as to uniformity in standards of examination, 209–212.

As a rule, are not changed from year to year, 213.

Examine the papers in London only, 216.



COLE, HENRY—*Examiners*—cont.

Are appointed by the Lord President, 236, 237. Usually go on for several years together; the best are kept with difficulty, 238. Their remuneration depends on the number of papers, at a fixed moderate fee, 239. Estimate of cost of examiners in science or art, for 1870-71, 13; payments to them, for preparation of examination papers, 7, 13. Best qualified to decide on competency of teachers, 23. Reports of, satisfactory, 24, 25. It is unlikely to find inspectors of elementary schools competent to act as examiners in science, 6059.

*Faversham.*

Instanced as an example of good organisation of schools, 198.

*Fees.*

Certain art students admitted without payment of science fees; system of fees proposed for projected college of science, 44. Moderate fees paid by artizans, who are only just beginning to pay them for scientific instruction, 2, 5960. Arrangement of, in estimate for proposed science college (under "Remarks"), 5953. Art masters could not exist upon fees paid by artizans even when combined with State payments on results, 5954. Greater part of science teacher's income derived from artizans' fees than from those of the middle class, 5961. In proposed training college full fees should be paid by those not intended to be science teachers, 5983.

*Fittings.*

The cost of all fittings (laboratory or others) are included in the estimates of 66,000*l.* and 45,000*l.* respectively; there is no reason to believe the expenditure will exceed the estimate, 6065-6070.

*Foster, Dr. Michael.*

Lectures by, at South Kensington Museum, 40.

*Frankland, Dr.*

Lectures by, at the College of Chemistry, 40. Comparison by, of his laboratory with those at Berlin, Bonn, Leipsic, and Zurich, 47. Complaint by, of inadequate accommodation at College of Chemistry, 47.

*Geology.*

Amount paid by State in 1867-8, in aid of, 115. Estimate of expense for teaching, and for professor and demonstrator, in proposed science college, 5953. A small typical geological collection would be required in proposed college, 5999.

*Geological Survey of the United Kingdom.*

Want of accommodation for, at Jermyn Street institution, which should be made efficient for Survey purposes, 51, 5985. Should be relieved by removal of mining school, 52, 53. Director of, should not be also head of a science school, 76. Its efficient working would be increased if the teaching at Jermyn Street were transferred to South Kensington, 6060.

*Geometry.*

Objections formerly held as to teaching geometry to carpenters and joiners, 6085.

*Glasgow University.*

More than 100,000*l.* purposed to be expended on, 6001.

*Government Grants in aid of Science.*

Rules for distribution of, 2. How distributed, 7, 13. Essential in forming proposed science school, 43. Estimate of amount to be allotted as grants for examples, for 1870-71, 7. State aid is necessary, even for elementary education; should take the shape of aid to local efforts, 114. Amount paid in 1867-8 for the encouragement of science in various ways in London and Scotland, 115. A distinct advantage to persons receiving, over private competition, 116. State aid should not be withdrawn merely to save the principle of not interfering with private enterprise; it is indispensable to the encouragement of science, 117. Need not be antagonistic to private enterprise, 118. State aid to science, as now given, might be better effected; definite payments to universities, &c., should be abolished, and the amount appropriated to scholarships obtained anywhere, 124. A place manifesting its earnestness for teaching science (as, for instance, Owens College) might receive grants for buildings, 125.

COLE, HENRY—*Government Grants in aid of Science.*—cont.

Should be abolished to all regius chairs in the kingdom, 129. The fact of examiners doing their duty, and the inspection, the only guarantee that money is spent properly 150, 155. A professor, with a positive salary from the State, should be required to receive scholars without fees, 230. To qualified places, should be made in aid of specific things, not grants in money, 232, 233. Should be confined to granting scholarships, aiding buildings, providing apparatus, &c., and establishing a training college for teachers, 240. 3,100*l.* paid to Scotch universities for instruction in science; very little direct aid given in England towards scientific instruction in colleges, 245. Probability of future State aid not being confined to artizans, but that all classes will insist upon participating, 5955. The less science teachers depend upon State aid the better, 5959. To present time, science teachers have been chiefly remunerated by, 5960. See also *Building Grants. Estimates.*

*Guarantee.*

The best guarantee for a student to remain in the public service is the public demand for his services. No precise guarantee can be exacted. If a man can better his position the influence is good, 5977-5979. If such guarantee be exacted there is an obligation to find the teacher employment, 5980. The fact of a man proving aptitude for science teaching, and willing to come to London to live on 50*l.* a year, and be trained, is a good guarantee in itself, 5982.

*Guthrie, Dr.*

Lectures to teachers by, at School of Mines, 40.

*Hofmann, Dr.*

College of Chemistry instituted to secure his services as professor, 88-90.

*Infants' Schools.*

Necessity of, distinct from those more advanced, 5955.

*Inspection of Schools.*

Desirable to have some work done by inspectors, which is not accomplished by paper examinations, 5973. Elementary and other schools might be embraced in one system of graduated inspection, under supreme authority of Education Department, 5974-5976.

*Inspectors of Science.* See *Science Inspectors.*

*Institutions (Literary and Scientific).*

Science schools have been carried on in, 12. Present demand in, for science teachers of advanced character, and probability of much greater future demand, 5955. See also *Mechanics' Institutes.*

*Jermyn Street Institution.*

Could not be used in carrying out scheme of Metropolitan College of Science. If maintained, it should keep to mining, mineralogy, and metallurgy only. Inconvenience of sending students from one place to the other, 5984. Great want of accommodation in. Should be confined to the Geological Survey. Even for this it will have to be reorganised, 5985. The apparatus at, if a change were made, would be transferred to Kensington; that is part of the saving. Not abundantly supplied with apparatus, 5996, 5997. The teaching of physics should be transferred from, to the new establishment, 5998. See *Royal School of Mines.*

*Joiners.*

In 1852 it was not proposed to teach geometry to carpenters and joiners, 6085.

*Laboratories (Chemical).*

Want of accommodation in those of the College of Chemistry and School of Mines, 46, 47. The existing, compared with those of Berlin, Bonn, Leipzig, and Zurich, 47. Cost of, at Kensington, 5953. Good accommodation for teaching in, at Kensington, 5986.

*Laboratories (Metallurgical).*

Jermyn Street laboratories could not be used in carrying out proposed college of science, 5984.

*Laboratories (Physical).*

One would be required in Metropolitan College of Science 5995.



COLE, HENRY—cont.

*Leipzig.*

Laboratory at, compared with Dr. Frankland's, 47.

*Local Committees.*

Always appoint science teachers, 2, 14.

*Local Secretaries.*

Estimates for payment of, 1870-71, 7.

Are paid a fee for each examination, 7.

*Machinery.*

Estimate of expense for teaching, and for professor and assistants, in proposed science college, 5953.

*Mathematics.*

Amount paid by the State in 1867-8 for encouragement of, in London and Scotland, 115.

Estimate of expense for teaching, and for professor and assistants, in proposed science college, 5953.

A large space not required for teaching, 5988-5991.

*Mechanics and Civil Engineering.*

Amount paid by State in 1867-8 in aid of, 115.

*Mechanics' Institutes.*

Have been used for science schools, 12.

Large per-centage of science instruction of the country given in, 37.

*Mechanism.*

Estimate of expense for teaching, and for professor and assistants, in proposed science college 5953.

*Metallurgy.* See *Mining and Metallurgy.*

*Metropolitan College of Science (proposed).*

Memorandum for establishing, referred to, and the scheme advocated, 42-45, 49.

South Kensington the proper locality for, 49, 54. Could be provided for there in a year, 56.

Belief in the increasing conviction in its favour; will be frequented wherever situated, 72.

The proposed training college for teachers would not be a substitute for the present system, only a supplement for its efficiency, 184.

Those who come to, must be certificated teachers, and they would require a year's training, or more, to fit for them for teaching science, 186-190.

Estimated annual cost of a pupil in, about 50l., 191.

Special application of science to industry and arts should not be taught there, save that in the third year two or three branches might be so treated, 201.

Ought not to extinguish the School of Mines, or of Naval Architecture and Engineering, 202, 203.

Should have two classes of students, one for intended teachers of classes, the other for teaching science in its application to industry, 205. The combination of theory and practice should be provided for, 208.

Not to be limited to those who are to follow the profession of teachers of science, but for general instruction, under certain conditions, 220, 223.

Students in, would be at their own expense, 224.

Government should provide for salaries, means of teaching, museums, apparatus, &c. on behalf of teachers, the public to have the advantage of attending the instruction, 225-227.

Establishment of, one means by which State aid to science should be applied, 240.

School of Mines should be continued as a special training college, 241.

There will be ample scope for teachers trained in, 242.

In order to bring existing State endowments into harmony with, a professor, for every 20l. of State money paid to him, should receive a free student; details, such as laboratory expenses, &c., to be arranged specially; under this plan the money now paid to Scotch Universities would provide for about 150 studentships, 245. Estimate of amount that would be required for scholarships, 245.

Teachers trained in, not to work at manual labour, as is done under Sir J. Whitworth's scholarships, 247.

Its prime function should be the training of teachers, as the thing most wanted at the present time, 248.

Undue competition with existing institutions easily to be avoided, 249, 250.

Estimate of annual expense of instruction in, prepared by Captain Donnelly, 5953.

Necessity for carrying out the proposed scheme; a superior class of science teachers being now, and will be more extensively required, 5954-5958.

Students trained in, should be taught the method of imparting knowledge to others, 5967-5972.

No precise guarantee for continuance of service can be exacted from teachers trained in, 5977-5979. A guarantee would necessitate the finding employment for the teacher, 5980. Willingness to come to London

COLE, HENRY—*Metropolitan College &c.*—cont.

to be trained, combined with skill in elementary teaching, a good guarantee in itself, 5982.

Students not becoming teachers might repay cost of instruction in; a man will follow his own interests, 5981. Full fees should be paid in, by others than science teachers, 5983.

The Jermyn Street institution could not be used for carrying out proposed scheme of, 5984.

Matters that would be required for: a physical laboratory, a small typical geological collection, and demonstrators of physiology, zoology, and botany, 5995-6000.

Being a national affair, it should not be conducted on a lower scale than Owens and other colleges, 6001.

Existing establishments should be used for, as much as possible, 6002.

Those who come to, to be made into teachers, would be probably without means, whom the State must maintain; if the systematic creation of a superior class of teachers be instituted, capital must be found for maintaining them while going through the operation, 6004-6006.

Conditions supposed as to the admission of teachers into, 6009.

Necessity of, because of the limited demand for science teachers, who must be forced into public acceptance, 6018, 6019.

Persons with an elementary knowledge of science, and some experience in teaching, would be preferably eligible for admission, 6027-6032.

Competition for entrance into, should be as fair as could be devised, 6033.

Fusion of School of Mines and College of Chemistry with, would be of public advantage, 6035.

Elementary instruction is not contemplated in, 6040-6042.

Assuming that the pupils of the existing Government schools are absorbed by the new school, it could not be efficiently carried out without the additional expenditure of 40,000l. or 50,000l., 6045.

The building for, should be on the other side of the road, so as not to impair the arrangements of South Kensington Museum, 6046.

Could be continued, in addition to other existing Government schools, even if the further grant of 40,000l. were refused, 6048, 6049.

Means to be taken for increasing efficiency and numbers of science teachers, supposing the training school be conceded, 6050.

If the sum desired for a training college be granted, it is desirable at once; it would be best to expend the 45,000l. in one year; temporary arrangements would be *plus* the sum asked for, 6061-6064.

Conditions to be fulfilled by students desirous of being trained as teachers of science, 6072.

No guarantee could be taken of students entering the college, as to devoting themselves to teaching; the best guarantee is the student's life, 6073, 6074.

*Middle-class Schools.*

Certain employment for science teachers in, 5956.

Might be embraced in one system of graduated inspection, under supreme authority of Education Department, 5974-5976.

*Mineralogy.*

Might continue to be taught at Jermyn Street, 5984.

*Mining and Metallurgy.*

Special instruction in mining possessed at School of Mines, 43.

Should continue to be taught at Jermyn Street, 5953, 5984.

*Mining Record Office.*

Will probably shortly have to be re-organised, 5985.

*Minute.*

In App. A. to First Report of Science and Art Department quoted, as to foundation of Department, 2.

Of 30th Dec. 1870, setting forth the conditions of admission for science teachers in May 1871, 6050. It differs from those of former years only in extension, not in principle, 6052-6056.

*Murchison, Sir R. I., Bart.*

Complaint by, of inadequate accommodation at School of Mines, 47, 51, 5985.

His functions as Director of School of Mines, 74-76.

*Museum of Practical Geology.*

Will probably have to be re-organised shortly, 5985.

*Museums.*

Proposed union of Museums of Geology in London and Dublin in one estimate, 2.

An important part of the subject of scientific instruction, 5953.



COLE, HENRY, Esq.—cont.

*Natural History.* See *Biology, Physiology, &c.*

*Natural Philosophy.*

State aid to, would be best applied by increased museum facilities and apparatus, 232.

*Nautical Astronomy.* See *Navigation and Nautical Astronomy.*

*Navigation and Nautical Astronomy.*

Estimate of expense of teaching, in proposed science college, 5953.

*Night Classes.* See *Evening Classes.*

*Office of Works.*

Demand for more accommodation in Jermyn Street institution, now before, 5985.

*Owens College.*

A place like, fairly entitled to a building grant from the State, 125.

More than 100,000*l.* purposed to be expended on, 6001.

Teachers trained at, could not be recognised by the State without personal attendance at a responsible place, 6003.

*Payments on Results.*

Are confined to artizan class, 2.

Payments to local science schools are made on results of examinations, 2.

Estimate under this head for year 1870–71, 7.

Teachers must have passed an examination to obtain, 16.

The real test of a teacher, 32.

At present, estimated at 24,000*l.*, 144. At the present rate of increase may amount to 80,000*l.* or more in course of next 10 years, 149.

Insufficient for support of teacher, 5962.

*Percy, Dr.*

Complaint by, of inadequate accommodation at School of Mines, 47.

*Philosophy (Natural and Experimental).*

Amount paid by State for encouragement of, in 1867–8, in London and Scotland, 115.

*Physical Geography.*

Estimate of expense for teaching, and for professor and demonstrator, in proposed science college, 5953.

*Physics.*

Estimate of expense for teaching, and for professor and demonstrator, in proposed science college, 5953.

A laboratory necessary for teaching, 5995.

Teaching and apparatus now in Jermyn Street would be transferred to proposed college of science, 5996–5998.

*Physiology, Zoology, and Natural History.*

Amount paid by State in 1867–8 in aid of, 115.

Demonstrator in physiology proposed for College of Science, 5953, 6000.

*Political Economy.*

The laws of, do not apply to education; if the public requires science teachers it must pay for their creation, hence the necessity for the proposed training college, 6007, 6008, 6012–6019.

*Porter, Mr.*

Minute made by, stating that the School of Art should not teach geometry to carpenters and joiners, 6085.

*Practical Art Department.* See *Department of Practical Art.*

*Prizes.*

Open to all classes, 2.

Of books, instruments, &c., estimate for payment of, for 1870–71, 7.

*Qualifications of Teachers.*

None required, except having been examined, 26.

*Regius Professorships.*

Should be abolished, 129.

The payments to, should be coupled with the obligation to receive students, 136.

*Rejections.*

Upon examination last year rather more than one third, 151.

Small number of, for copying and such like faults, 153.

*Royal College of Chemistry.*

Partial attendance of teachers of chemistry at, 13.

Instruction at, 38–40.

Combination of, with Royal School of Mines and Royal School of Naval Architecture, as a Metropolitan College of Science, advocated, 42–45, 49.

Inadequate accommodation at, for pupils, 46, 47.

Lease of School of Chemistry about to expire, 48.

26060.

COLE, HENRY, Esq.—*Royal College of Chemistry*—cont.

Its origin, staff, progress, incorporation with Science and Art Department; to a great extent self-supporting; its connexion with the School of Mines, 85–90.

Receives 800*l.* a year from the State for "local expenses," 95.

Circumstances leading to its union with the School of Mines should be borne in mind, 97.

For some students no fees are paid, 98.

Elementary knowledge should certainly not be taught in; some qualification must be required, 6010.

Fusion of, with the proposed training college contemplated, 6035.

*Royal College of Science, Dublin.*

A centre for obtaining science instruction, 2. Scholarships gained in, by students at science classes, 18.

Relation of, to Science and Art Department, 19.

*Royal School of Mines.*

A centre for obtaining science instruction, 2. Scholarships gained in, by students in science classes, 18.

Relation of, to Science and Art Department, 19. Instruction to teachers given in, last year, 38–40. High scientific instruction given in, 43.

Combination of, with the Royal College of Chemistry and Royal School of Naval Architecture, as a metropolitan college of science, advocated, 42–45, 49. Anything now done in, would not be interrupted or impeded by such combination, 45.

Inadequate accommodation at, for students, 46, 47.

Geological Survey would be relieved by removal of, from Jermyn Street, 52, 53.

Some professors of, in favour of proposed school of science, 72, 73.

Connexion of College of Chemistry with, 88–90.

Originated mainly by Sir H. De la Beche; its early name and objects; change of title, and desire of the then Government to convert it into a general school of science; objection of the professors thereto, and their consequent disagreement with the Department, 100–112.

Proposed to be continued as a division of the great training college, 241.

Fusion of, with the proposed training school contemplated, 6035.

*Royal School of Naval Architecture.*

Chemical examinations of science teachers might be held at buildings of, at South Kensington, 13.

Practice in, quoted as an instance of what is desired in the proposed training college for teachers, 227.

About 45,000*l.* additional would be required to fit the building at South Kensington for a training college, 5953. The buildings in progress there are intended, and could also be made available, for teaching chemistry and various sciences, 5986, 5987, 6046, 6047.

*Salisbury, Lord.*

His intention, as Lord President of the Council, as to science instruction, 2.

*Scholarships in Science.*

Estimate for, for year 1870–71, 7.

Gained by students in science classes, 18.

All regius chairs in the kingdom should be translated into scholarships; out of the payments made on account of the latter the incomes of professors would be secured, 127–134.

There would be no grievance in requiring a professor now receiving 400*l.* a year to receive 20 students at 20*l.* each, 134, 136.

Gained in open competition would be the most wholesome way of encouraging science, 226. Might be held at recognised institutions, 226, 231. One of the means to which State aid should be applied, 240.

Estimate of amount to be required for payment of, under the proposed plan, 245.

Three forms of, should be established: 1st, of 70*l.* per annum, with a sum for paying fees; 2d, of 50*l.*, with sum for fees; 3d, a sum for fees alone. Student to elect institution at which to hold his scholarship, 245.

State scholarships should not be taken in the State institution; they should be kept for encouragement of work done outside it, 250.

*School of Art.*

The experiment in, of applying art to specific industries, did not succeed, 204.

*Schools (General).*

Present demand in, for science teachers of advanced character, 5955–5958.

Necessity for different grades of, for educational purposes, 5955.



COLE, HENRY, Esq.—cont.

*Science.*

- Details of branches of science most cultivated in science schools, 6.
- Estimate for payments under this head for 1870-71, 7.
- Science teaching chiefly conducted in evening classes to artisans, 171.
- Details of, in day and evening classes, 172, 173.
- Merit of present system of science teaching consists in its wide diffusion in humble spheres of action, and its struggles against difficulties, 196, 197.
- Application of science to special industries should not be made a rule in proposed training college for teachers; the experiment did not succeed in the School of Art, 201-204. Two classes might be admitted in the college, one for intended teachers of science classes, the other for instruction in science applied to industry, 205. The combination of theory and practice desirable, 208.
- Estimate of expense of scholarships in science proposed to be established under the new plan, 245.
- 3,100*l.* paid to Scotch universities for instruction in; very little State aid given in England towards scientific instruction in colleges, and the like, 245.
- An elementary instruction in, very desirable in all who propose to enter the projected training college; persons with some experience in teaching would be preferably eligible for admission, 6072-6032.

*Science and Art Department.*

- Witness is secretary of, 1. Connexion of his office with advanced scientific instruction, 19, 20.
- Purposes for which founded; change of Department of Practical Art into Department of Science and Art; object of the change set forth in Minute, App. A. to First Report of Science and Art Department; extension of the principles of the Department in teaching certain sciences; growth and details of the system as now in action; 2, 78-80.
- Incorporation of College of Chemistry with, 86.
- If told to do its best with existing facts at South Kensington, something creditable might be done, 6047.
- The training school for teachers, in addition to other government schools now existing, would be continued 6048; even if the further grant of 40,000*l.* were, refused, 6049.
- No savings in, could be suggested as a set-off against the 40,000*l.* or 50,000*l.* desired for extension of science school buildings, 6060.

*Science Classes.*

- Increase of (between 1860 and 1865) from 9 to 800, with 30,000 pupils, 2.
- Any locality may establish science classes or science schools, and appoint the teachers, 2.
- Examinations of, and system of payments to, 2.
- Numbers of, in day and evening schools, 172, 173.
- Disadvantage of evening science classes; the teacher fatigued after his ordinary labour, 176-183. The present system must continue, with modifications, for a long time, 184.
- Desirability of evening science classes, although many students enter merely for relaxation, 199, 200.
- Advocacy of, by Adam Smith, 200.
- See also *Science Schools*.

*Science Directory.*

- Contains a full account of the rules guiding distribution of public money for encouragement of science, 2.

*Science Examinations.* See *Examinations*.

*Science Examiners.* See *Examiners*.

*Science Inspectors.*

- Only two official inspectors of science and art, and two inspectors of local schools, permanent officers, 7.
- Additional, appointed within the last three years; reasons for their appointment, 33-37.
- It would be desirable to have work done by, irrespective of paper examinations, 5973.

*Science Scholarships.* See *Scholarships in Science*.

*Science Schools.*

- Any locality may establish, and appoint teachers; payments on behalf of, 2. Map showing number of, in United Kingdom, 2. Have prospered beyond anticipation, 3.
- Examinations in, much higher than when first established, 4. Great variety in, 5. Detail of branches of science most cultivated in, 6.
- Have been carried on in all kinds of buildings, 12.
- Subsequent career of pupils in, 18.
- General science must be taught in a special school, 81.

COLE, HENRY, Esq.—*Science Schools*—cont.

- There must be training schools for teachers in science, 83, 84.
- State endowments in, should be thrown open to all classes of society without restriction, 121-123.
- Instances of earnings of teachers in, 139-141.
- Estimates for, according to present system, must largely increase, 143, 144, 149.
- Very few grants for erection of scientific day schools; day schools necessary as a sphere of action for science teachers, 192-195.
- The elementary instruction now taught by science masters in evening schools is in harmony with Sir J. Whitworth's scholarships and endowments, 206, 207.
- It would not be sufficient to introduce students who have studied chemistry, for example, into a school simply to learn how to teach; some consideration must be had for their maintenance while so learning; the proposed training college the best solution of the difficulty, 6005, 6006.
- Students in the proposed college should be required to attend local science schools in London, in order to acquire a knowledge of the laws of teaching, and skill in their application, 6077, 6078.

*Science Students.*

- In science schools, subsequent career of; many have remained as teachers, some have gone into trade, 18.
- Collusion between, at examinations, and between students and teachers, 35-37.
- Refused admission to laboratories at Oxford Street and at Jermyn Street, for want of room, 47.
- Objections to sending them from one place of instruction to another; the teachers should be brought to the students, 5985.

*Science Teachers.*

- Teachers of science classes and schools are appointed by local committees, 2, 14. Must have passed an examination or they would get no payment; in most cases the occupation of science teacher is supplementary, 16.
- A selection of local teachers in science brought up to London for instruction in teaching, 13.
- Teachers of chemistry formerly brought up to Kensington for *vivâ voce* examination; the practice discontinued; partial attendance of, at College of Chemistry, 13.
- Paid only, not appointed, by Science and Art Department, 15.
- Passing examination is a proof they do their work adequately well, 17.
- A training school for teachers in science ought to be established, 83, 84.
- Instances of amount of earnings of teachers of science, 139, 140.
- Desirability of creating a higher class of science teachers, who might be employed in both day and evening schools without being overworked, 198, 5965.
- Various occupations of science teachers; allowed to teach science only in the evening, often after teaching an ordinary evening school; such employment of certificated masters only transitional, and an exceptional system, adopted under constraint, 174-183, 185.
- The creation of science teachers in greater numbers would tend to increased instruction in science in the daytime, 184.
- Who come to a science training college must be certificated; they would then require a year's training, or more, to fit them for teaching science, 188-190.
- In proposed training college will rarely devote a third year to the application of science to special industries, 201.
- Estimate of annual expense of college for training, by Captain Donnelly, 5953.
- A training college for, is required, because of the want of a superior class of teachers, 5954.
- Teachers of more advanced character are wanted now, and will shortly be much more required, in institutions and schools, 5955.
- Certainty of science teachers being required in elementary, middle-class, and endowed schools, 5956-5958.
- The less they depend upon State aid, and the more on results of teaching, the better, 5959.
- Hitherto have been chiefly remunerated by the State. Great difficulty of their making a living out of other sources, 5960-5962.
- The present useful science system should be supplemented by more highly instructed science teachers, 5963, 5964.
- The master of an elementary school should not be hindered from teaching science in the evening, 5966.
- Competency of, to impart instruction should be ascertained by the professors who train them, 5967.



COLE, HENRY, Esq.—*Science Teachers*—cont.

Few have a great aptitude for efficient teaching before coming up to be trained; it should be seen that students have a reasonable capacity for imparting instruction, 5969, 5982.

Capability of being taught the method of communicating knowledge, 5970-5972.

No guarantee of continuance of service could be exacted from those who had received the benefits of State training, 5977, 5982. If they can better themselves in other directions it is desirable they should do so, 5978, 5979. If a guarantee be exacted, there is an obligation to find the teacher employment, 5980. The best guarantee is the evidence of a teacher's life, 6073, 6074.

Those renouncing their profession might reimburse the State the cost of their training; there are no means of compelling a man not to follow his own interests, 5981.

Probably not more than five per cent. of those who are trained as, would emerge from that station, 5982.

Number of teachers to be trained must be determined by Chancellor of Exchequer. The estimate is calculated upon a hundred, 5993, 5994.

One place should be specially adapted for teaching of, 6003.

More stringent rules might be made as to admission of, than were necessary at the institution of art schools, 6021-6023.

Not necessary to have been elementary teachers in schools, 6025.

Persons qualifying to become elementary teachers might be admitted as, under various conditions, 6026.

Means to be taken to increase the numbers and efficiency of, supposing the proposed training school be conceded, 6050.

Minute of 30th Dec. 1870, as to admission and subjects of examination for 1871; provides no change of principle, but some extension and a slight change of subjects, 6052-6056.

Enumeration of conditions to be fulfilled by students desiring to enter the proposed training college for science teachers, 6072.

No opinion can be formed as to the length of training necessary to fit teachers for functions likely to be required 10 years hence, 6075.

Will possibly imitate art students in the practice of leaving college with only one or two certificates out of the three or six demanded for thorough training, 6075.

Hard lines of definition cannot be laid down as to the length of a man's stay; much depends on the requirements of the district from which he came, 6076.

One means of imparting a knowledge of the principal scientific laws of teaching, and skill in the application of those laws, would be to cause the student to attend, under qualified superintendence, the local science schools of London, 6077, 6078.

See also *Art Teachers. Teachers (generally).*

*Science Training College.* See *Metropolitan College of Science (proposed).*

*Scientific Instruction.* See *Education in Science.*

*Secondary Schools.*

May be concentrated wherever there are 10,000 people, 243, 244.

*Smith, Adam.*

Advocacy of science classes by, 200.

*South Kensington.*

The proper locality for a metropolitan college of science, 49, 54.

Present building at, fully occupied, 56, 57.

Estimates for buildings at, for current year, 62-71.

The new buildings at, are intended for a school of naval architecture and marine engineering, with accommodation for teaching chemistry, 5986.

Amount of accommodation required in, for teaching, 5987-5991.

No theatres available at, for teaching purposes, 5992.

*South Kensington Museum.*

The arrangements of, would be impaired by placing the building for the proposed training school upon its ground; any extension should be on the other side of the road, 6046, 6047.

*State Aid.* See *Government Grants in aid of Science.*

*State Competition.* See *Competition.*

*State Endowments in Science Schools.*

Should be thrown open to all classes of society without restriction, 121-123.

COLE, HENRY, Esq.—cont.

*State Schools.*

Elementary instruction should certainly not be imparted in; some qualification should be required in students, 6010.

*Students.* See *Art Schools. Science Students.*

*Teachers (generally).*

Qualified opinion of competency of, 22.

No qualifications except having been examined are required for, 26.

Relative qualifications of, under former and present standards, 28, 32.

Suggestion on the subject of rendering teachers better qualified for teaching, stated in a memorandum for establishing a metropolitan college of science, 12.

Tendency of new teachers to cram; worst cases of cramming occurred under those supposed to be highly skilled, 160-164.

Good results from giving special instruction to, to teach physical science; desirability of improving the teaching power of masters; number of, as recognised under special instruction; compelled to work while in London, 165-168.

A teacher must pass an examination under present system before he can start as such, 234. Under proposed central system the examination will be more strict, 235.

Public demand outruns the supply of teachers highly trained, 242-244.

Art teachers could not subsist upon fees paid by artisans, 5954.

Their position in the tripos no measure of their capacity to teach, 5968.

Capability of being taught the method of communicating knowledge, 5970-5972.

The class of people who would come to be trained as teachers would probably need assistance while going through the operation; if elementary teachers are taken away from their schools, it could scarcely be at their own risk, 6005, 6006.

The laws of political economy do not apply to education; if the public want a superior class of teachers it must pay for the creation of them; hence the necessity for the proposed training college, 6005-6008, 6012-6019.

Conditions as to admission of teachers into the proposed college must of course be laid down; certain conditions supposed, 6009.

The demand on the part of manufacturers for experts in chemistry, for example, would not be so great as to interfere with the supply of school teachers, 6011.

Persons with an elementary knowledge of science, having had already some experience in teaching, would be preferably eligible for admission into the proposed training college, 6027-6032.

See also *Art Teachers. Elementary Teachers. Science Teachers.*

*Teaching.*

Experience has shown necessity of particular instruction in art of, 6003.

*Trade Schools.*

Creation and indifferent success of, 2.

*Training Colleges.*

There are now about 40, and there should be one specially for training science teachers, 6003.

See *Metropolitan College of Science (proposed).*

*Travelling Expenses.*

Estimate of, of inspectors, masters, &c., for 1870-71,—13.

*Whitworth, Sir J.*

The elementary instruction in evening schools is in harmony with the general idea of his scholarships and endowments, 206.

Young men to be trained as teachers not to work at manual labour, as is done under Sir J. Whitworth's scholarships, 247.

*Zoology.*

Amount paid by State in 1867-8 in aid of, 115.

Demonstrator in, proposed for college of science, 5953-6000.

*Zurich.*

Laboratory at, compared with Dr. Frankland's, 47.

HUXLEY, PROFESSOR, LL.D., F.R.S. (Index of his Evidence.)

*Age of Science Students.*

Valuable scientific instruction may be imparted to children under 12, 315, 318, 319.

Definition of school age by Factories' Act, 315.

The Department elementary science papers are quite adapted for children of 11 or 12 years, 348, 349.

Science candidates vary in age from 11 to 45 years, 350.



## HUXLEY, PROF.—cont.

*Arnott, Dr.*

His suggestion for instructing children by scientific toys, 322.

*Botany.*

Should be taught in elementary schools; the only branch of natural science to be taught at first hand conveniently, 355, 356.

*Chemistry.*

Elements of, should be taught in elementary schools, 355, 356.

*Children.*

Valuable scientific instruction might be imparted to children under 12 years of age, 315, 318, 319. Necessity of giving practical instruction to, 320, 321. Scientific toys for, 322.

*Viva voce* better than written examinations for, 338, 342. The Department elementary science papers are quite adapted for, 348, 349.

Elementary physiology may be well taught to, 349.

*Cole, Henry, Esq., C.B.*

Reference to evidence of, respecting mode of ascertaining qualifications of teachers, 273.

*Cramming.*

For purpose of preventing, candidates are not allowed to go up for advanced stage without having passed through elementary one, 256, 258. Evil of, adopted by some teachers for the purpose of making money, 265. The old plan of ascertaining qualification of teachers was a great check to, 273.

*Donnelly, Captain, R.E.*

Reference to his paper of 1867 as to teaching of science in elementary schools, 340.

*Education Department.*

Connexion of Science and Art Department with, an anomaly, 354.

*Elementary Instruction.*

Scientific teaching should be made a fundamental part of, 314.

*Elementary Schoolmasters. See Schoolmasters.**Elementary Schools.*

Great majority of science teachers are certificated masters of, 305.

Good instruction cannot be given in, by masters who teach in the evening, 311, 325.

Science should be made an integral part of the instruction in, 314. Valuable scientific instruction might be imparted to children in, 315, 318, 337. Physical geography, physics, and mechanics might be easily taught in, 319.

Necessity of giving practical instruction in, 321.

Should be supplemented by secondary schools, 324.

*Viva voce* better than written examinations in, 338.

Examinations in, should be conducted by the school inspector, 339.

Only a few scientific subjects should be taught in, viz., mathematics, physical geography, elementary physics and chemistry, botany, and human physiology, 355, 356.

*Examinations. See Science Examinations.**Factories' Act.*

Definition of school age by, 315.

*Government Grants in aid of Science.*

Imperfect papers have to be examined, and consequently paid for, 268. Expense would be saved by diminution of bad papers if teachers were examined specially; expense of examining teachers would be trifling, 274, 277. Full value for, can only be secured by thorough training of teachers, 291.

*Honours.*

Rarely attained in the science examinations, 261. Not a necessary qualification for science teacher, 282.

*Laboratories.*

No biological laboratory at School of Mines; this is requisite for proper instruction in natural history, 296, 297.

*London.*

Desirability of science teachers being brought to, for instruction, 275-277, 289.

*Mathematics.*

Should be taught in elementary schools; are taught now in better class of elementary schools, 355-357.

*May Examinations. See Science Examinations.*

## HUXLEY, PROF.—cont.

*Mechanics.*

The elements of, might be easily taught to children under 12 years of age, 319.

*Metropolitan College of Science (proposed).*

Science teachers should all qualify in a normal training school, 289-291, 313. Other students might also be admitted; but the chief object should be to obtain a body of trained teachers all over the country, 292-295.

A foundation for, may be found in the School of Mines, the School of Chemistry, and the School of Naval Architecture, 296.

Theoretic science, applied science, and the method of imparting science to others, could not be taught in, by the same man, 330.

Should be for teaching pure science, and the method of teaching it to others, 331, 334.

Danger of combining the technical with the normal school, 335, 345-347.

Instruction in certain allied subjects might be given by same teacher in, 351.

*Mineralogy.*

Special instruction in, might interfere with training of teachers in a science college, 292.

*Mining.*

Special instruction in, might interfere with training of teachers in a science college, 292.

*Payments on Results.*

Only given for subjects in which the teacher has qualified. Examination for qualification to earn, dispensed with, where candidate has taken a university degree, &c., 283, 284.

When rejections are very bad, payments on passed papers might be lessened, 302.

If payments be made on results, the inspection should be local, 342.

*Physical Geography.*

The elements of, might be easily taught to children under 12 years of age, 319.

Should be taught in elementary schools; no other branch of science (except mathematics) is now taught in them, 355, 358.

*Physics.*

The elements of, might be easily taught to children under 12 years of age, 319; and should be taught in elementary schools, 355, 356.

*Physiology (Animal).*

Examination in, entirely independent of zoology, 254.

Result of examinations in, in 1869, 262, 263. Steady yearly improvement in examinations in; address to teachers of, on evil of cramming, 265.

Reasons for larger number of candidates for, than for zoology. Great pains have been taken to organise a system for teaching human physiology, 266.

Necessity of practical examinations in, for science teachers, 275.

Sufficient might be taught to children to enable them to answer the elementary examination questions, 349.

*Physiology (Human).*

Should be taught in elementary schools, 355, 356.

*Practical Instruction.*

Desirability of testing science teachers as to their ability to impart practical instruction, 275.

Deficiency in means of imparting, at School of Mines, 296.

Necessity of, for children, 320, 321.

Practical modes of teaching in Prussia, 320.

*Prussia.*

Practical modes of teaching in, 320.

*Revised Code.*

Definition of school age by, 315.

*Royal College of Science (Dublin).*

Examination for qualification to earn payments on results dispensed with for associate of, 283.

*Royal School of Mines.*

Examination for qualification to earn payments on results dispensed with for associates of, 283.

Great want of mathematical teaching in, and deficiency in means of teaching practically most subjects. No biological laboratory at, 296-299.

Would not interfere, but might co-operate with, other technical schools, 336.

The instruction in, is not general, but very specific and particular, 346.



HUXLEY, PROF.—cont.

*Royal School of Naval Architecture.*

Would not interfere, but might co-operate with, other technical schools, 336.

*School Inspectors.*

Science examinations should be conducted by, in elementary schools, 339.

Scientific school inspectors might easily be found, 341.

*Schoolmasters.*

Are paid only for those who pass the science examinations, the amount depending upon the class in which candidate passes, 252.

Elementary schoolmasters form the great majority of science teachers, 305. Large per-centage of rejections may be attributed to this fact, 306.

Minute rescinded which formerly restrained them from teaching in the evening, 307. Reduction of payment to, an inducement for them to teach in the evening, 308, 309. Good instruction cannot be given by, under these circumstances, 311.

*Schools.*

Each school examined receives its papers on the same day, the answers being written under the inspection of the committee, 252.

It can be ascertained what schools are doing good work; unsatisfactory state of certain schools, 267.

Examiner should know nothing of the schools whence the examination papers come, 278.

See also *Elementary Schools. Secondary Schools. Science Schools. Technical Schools.*

*Science and Art Department.*

Rules for conducting examinations adopted by, and approval of the same, 252, 269, 270.

Syllabus of science subjects published yearly in Directory of, 258–260.

Great amount of good done by system of, which good will be immensely increased if examiners work with care, 265.

Reference to Captain Donnelly's paper of 1867, respecting teaching of science in elementary schools connected with, 340.

Connexion of education department with, an anomaly, 354.

*Science and Art Directory.*

Elaborate syllabus of the subjects for examination published every year in, 258–260.

Extract from, respecting qualifications, &c. of teachers, 283.

*Science Examinations.*

Method adopted by Department for conducting; schools where examinations are held receive their examination papers on the same day, 252.

Elementary examinations must be passed previously to entering for advanced ones, 256, 258, 261.

Held once a year, in May, 257.

Elaborate syllabus of subjects for, published annually in Science and Art Directory, 258–260.

Honours rarely attained in, 261.

More probably pass the elementary stage than the advanced one, 262.

Much greater knowledge of the subject is required for advanced than for elementary stage, 263.

Result of examinations in animal physiology and zoology in 1869, 262–264.

A great amount of good is being done by the system of, which good will be increased if examiners work with care; necessity of raising the standard of; steady yearly improvement in subjects of animal physiology and zoology, 265.

Something should be done with teachers who send up imperfect candidates, because of the cost to the State for examination of papers, 268.

Chief examiner wholly responsible for, 272.

There should be special examinations for science teachers, 273.

Extract from Directory respecting, 283.

Where rejections are very bad payments on passed papers might be lessened, 302.

Imperfectly prepared candidates will be sent up on the chance of drawing a prize, 303.

The primary training colleges not adapted for conducting, because of the difficulty of getting examiners who will work together, 327.

*Viva voce* examinations should follow the written ones, 328. *Viva voce* better than written examinations for young children, 338, 342.

In elementary schools, should be conducted by school inspector, 339.

Want of primary instruction shown by, 343.

HUXLEY, PROF.—cont.

*Science Examination Papers.*

Preparation and transmission of; all schools to be examined receive them on the same day; numbered answers only are returned to the examiners; plan of assigning marks for, 252.

The questions in, are set in three groups, 256.

Failures and successes of, in animal physiology and zoology, in 1869, 264.

Ten per cent. of, would do credit to any teaching, 265.

Cost to the State for examining those of improper candidates, 268.

Number of bad papers would diminish if teachers were examined specially, 273, 274.

It is better for examiner not to know whence the papers come, 278.

Not so good for young children as *viva voce* examination, 338, 342.

Great want of primary instruction shown in, 343.

The elementary papers are quite adapted for children of 11 or 12 years of age, 348, 349.

*Science Examiners.*

Vigilance of, should be directed to check the tendency to send up unqualified candidates, 304.

Difficulty of managing, if examination centres are scattered over the country, 327.

Their instructions from the Department, and method of preparing and transmitting examination papers. They know nothing of the schools or candidates examined, but affix their marks to the numbered answers, and return them to the Department. Where the examination is large, are allowed one or more assistants, 262.

Preparation of papers by, in three groups, and rule for prevention of cramming, 256.

If they work with conscientiousness a great increase in the good already doing will take place; necessity seen by, of gradually raising the standard. The evil of cramming can be remedied by, 265.

Approval of rules laid down by Department for guidance of, 269, 270.

Recommendation of assistant examiners by chief examiner, and appointment of same by Lord President, 271, 272. Chief examiner is responsible for the whole examination, 272.

Desirability of teachers undergoing practical examination before, 275.

It is better for examiners not to know whence the examination papers come, 278.

Formerly came in contact with teachers during examination only, 279.

They passed only qualified teachers, 280.

*Science Examiners (Assistant).*

One or more, allowed to examiner in large examinations.

Plan pursued by examiner with respect to, 252. Sufficient uniformity ensured by, to secure justice to the students, 255.

Recommended by chief examiner, and appointed by Lord President, 271, 272.

*Scientific Instruction.*

Should be made a fundamental part of elementary instruction, 314.

Might as well be imparted to children as the theology, &c. now taught, 315, 318.

Elementary physical geography, physics, and mechanics, might be taught to children under 12 years of age, 319.

Practical teaching essential, 320, 321.

Dr. Arnott's toys for, 322.

The instruction given in primary schools should be developed in secondary schools, 324.

Should not be given by teachers of elementary day schools, 325.

Theoretic science, applied science, and the method of teaching science, could not be taught by the same man, 330.

Pure science, and the method of imparting it to others, should be taught in the normal school, 331, 332.

A scheme providing for, should be so constructed as to pick out the best men, without restriction to trades, and the arts will get the benefit, 333.

Can only be obtained now in populous places, but with compulsory education an alteration will take place, 352, 353.

Should not be separated from general education, 354.

Only a few subjects of, should be taught in elementary schools, viz., mathematics, physical geography, elementary physics and chemistry, botany, and human physiology, 355, 356.



## HUXLEY, PROF.—cont.

*Science Schools.*

Better for the examiner not to know from what schools the papers come, 278.

Mostly taught by certificated masters of primary schools, 305, 306.

Necessity for practical teaching in, 321.

Could only now be formed in populous places, but with compulsory education an alteration will take place, 352, 353.

*Science Students.*

Must choose one of the three divisions into which the examination papers are grouped, 256.

Not to go up to advanced stage without having passed in elementary one, 256, 258.

Statement of subjects for, published annually in Science and Art Directory, 258–260.

A large number of, have acquired a fair amount of thorough information, 260.

Reasons why larger number of, in subject of animal physiology than of zoology, 266.

Show a great want of primary instruction in their examination papers, 343.

Their ages vary from 11 to 45, 350. The greater number of the older pass, and the greater number of the younger are rejected, 350.

*Science Teachers.*

System of cramming adopted by some, for the purpose of making money. Address to, on the evils of cramming, 265.

Something should be done with those who send up imperfect candidates, because of the cost to the State for examining their papers, 268.

Objections to the late change with regard to ascertaining qualifications of; they should undergo a special examination; it would be economical on the whole, by diminution of bad papers, 273, 274, 310.

Necessity of practical examinations for; desirable they should come to London, or where they could be in personal contact with examiners, 275–277. Formerly they came in personal contact with examiner during examination only, 279.

Not passed unless qualified; passing in advanced stage, but not in honours, is necessary for becoming a science teacher, 280–282.

Practically there is no guarantee as to fitness of. Extract from Science Directory respecting qualification of. Examination dispensed with if candidates are associates of School of Mines or College of Science, Ireland, or have taken degrees in universities, 283.

Payments on results are properly gained in those subjects only in which teacher has taken a certificate, 284–286.

Should all pass through a normal school in London, 289, 295.

Payments to, for passed papers, might be lessened, in the case of a large number of bad rejections, 302.

Great majority of, are certificated teachers of primary schools, which may account for the large per-centage of rejections, 305, 306. Good instruction cannot be given by those engaged as elementary schoolmasters, 311.

It would not be advisable for the same man to teach theoretic science, applied science, and the method of instructing in science, 330.

A general knowledge of the application of science to industry is of no use to teachers; special knowledge desirable, 345, 346.

*Secondary Schools.*

Instruction given in primary schools should be developed in, 324. Teachers of, should not have charge of day schools, 325.

Provision for, would not diminish the importance of technical instruction in London, 334–336.

*Switzerland.*

Practical modes of teaching in, 320.

*Syllabus of Science Subjects.* See *Science and Art Directory.**System of Examinations in Science.* See *Science Examinations.* *Scientific Instruction.**Technical Schools.*

Not objected to, in London or elsewhere; inadvisability of combining technical with normal school, 334–336.

*Theology.*

If elementary education now include difficult problems in dogmatic theology, science may very well be taught, 315.

*Toys (Scientific).*

Dr. Arnott's suggestion for instructing children by, 322.

## HUXLEY, PROF.—cont.

*Trades.*

Inadvisability of attempting to deal directly with trades with regard to science teaching, 333.

*Training Colleges for Elementary Teachers.*

Might be used for examining science teachers, but for the difficulty of getting the examiners, because the more examiners, the less uniformity in the examinations, 327.

*Zoology.*

Examination in, entirely independent of physiology, 254.

Result of examinations in, in 1869, and steady yearly improvement in the same, 262–265.

Objections to superficial teaching in. Smaller number of candidates for, than for physiology, 266.

Cannot be taught conveniently 356.

## REEKS, TRENHAM, Esq. (Index of his Evidence.)

*Accommodation for Science Purposes.*

Increased space desired by School of Mines' professors; students have been refused for want of room in laboratories, 400–402, 415–417.

Want of room for Survey offices; publication of maps impeded thereby, 408. Premises not large enough if classes were transferred to Kensington, 409.

Inefficiency of laboratories of College of Chemistry, 415–417, 538. Government departments (as the Inland Revenue now) might profit if there were more room therein, 519, 549, 550.

*Age of Science Students.*

No limit of age for students of School of Mines, 380.

*Agriculture.*

Application of chemistry to, the great notion of Sir H. De la Beche, 464–469.

*Apparatus for Science Purposes.*

Provided by Government at School of Mines, 488, 489.

*Applied Mechanics.*

Thirty-six lectures on, are delivered to School of Mines' students, 365.

*Artizans.*

No students of the artizan class in School of Mines, 533.

Special lectures delivered to, in the evening, in the School of Mines, on payment of 6d. for six lectures; great demand for tickets, 534–537. No examination follows, 558.

They take greater interest in abstract questions of science than in what applies to their own pursuits, 559, 560.

Lectures on all the School of Mines' subjects are delivered to artizans, 564, 565.

*Associates of the Royal School of Mines.* See *Royal School of Mines' Students.**Bergakademie, Freiberg.*

School of Mines will compare favourably with, in point of numbers, 543–545.

*Brewers.*

Many School of Mines' students study with a view of applying their chemical knowledge as brewers, 377.

*Chemistry.*

Seventy lectures on, delivered to School of Mines' students, 365. Many attend the course with the view of becoming manufacturing chemists, dyers, brewers, &c., 377.

Application of, to agriculture, the great notion of Sir H. De la Beche, 464–469.

See *Royal College of Chemistry.*

*Civil Service Commission.*

Do not now examine for Geological Survey appointments, 523, 526–528.

*Coal.*

Allusion to statement that half the coal of Staffordshire has been lost for want of scientific knowledge, 482.

*Colonies.*

Appointments on colonial geological surveys given to School of Mines' students, 437.

*Cost of Science Teaching.*

Cost of School of Mines' students, 443–446; of professors, prizes, lectures, &c., 449–451, 484–492, 560–563.

Cost of College of Chemistry, 499, 504, 512.

*De la Beche, Sir Henry.*

Jermyn Street building constructed in accordance with ideas of. His great notion was the application of chemistry to agriculture, 464–466.



REEKS, TRENHAM, Esq.—cont.

*Dyers.*

Many School of Mines' students enter with a view of applying their chemical knowledge as dyers, 377.

*École des Mines, Paris.*

School of Mines will compare favourably with, in number of students, 543–546.

*Examinations (Royal School of Mines).*

After every course students are examined, and awarded certificates according to merit, 369–371, 427–429.

No matriculation for any student, 394, 423.

A preliminary examination in mathematics would exclude many School of Mines' students, 433.

No examination follows the evening lectures to artisans in School of Mines, 558.

*Examinations (Science and Art Department).*

Free students for School of Mines are selected at the May examinations, 391.

*Fees.*

Amount paid by School of Mines' students, 379, 483.

School of Mines' fees are divided between professors and registrar; Government retaining one-eighth, 484, 485.

Paid for Inland Revenue students to College of Chemistry, 516.

Paid by occasional students in School of Mines. Half fees only paid by army and navy officers, certificated schoolmasters, &c., 531.

Sixpence is charged for a course of six lectures to working men, 533.

*Frankland, Dr.*

Delivers 70 lectures to School of Mines' students on chemistry, 365.

Statement of, quoted, that six or eight students are excluded every year from College of Chemistry for want of space, 415.

Inland Revenue officers attend lectures of, and are examined by, 516–518.

*Geology.*

A special subject at the School of Mines, 363.

Thirty-six lectures on, are delivered to School of Mines' students, 365.

A competitive examination in geology was formerly adopted for Survey appointments, 526.

*Geological Survey of the United Kingdom.*

From the Survey and Museum the School of Mines arose, 362.

Many School of Mines' students enter with a view of getting on the Survey, 377.

Want of office room in Jermyn Street for surveyors; publication of maps impeded thereby, 408.

No notion originally of connecting School of Mines and Survey, 460.

Appointment of School of Mines' students on Survey; appointments not confined to students, 495, 520, 522, 524, 525.

Civil Service examination dispensed with for Survey; appointments being temporary, 523, 528, 530.

Survey is facilitated by choosing officers who have been educated in the School of Mines, 551, 552.

*Goodeve, Professor.*

Thirty-six lectures delivered by, on applied mechanics, to School of Mines' students, 365.

*Government.*

Free students kept by, at School of Mines, 372, 390.

These do not usually become science teachers, 447.

Representation to, of want of room for Survey offices, 408.

The building in Jermyn Street, the lease of an adjoining house, and the College of Chemistry, belong to Government, 410–414.

Attention of, has been called to want of mathematics in School of Mines' teaching, 430.

Appointments on the Geological Survey, &c. made by, 435, 447.

Expense of Government free students is charged to School of Mines, 445, 446.

College of Chemistry (which had not answered its purposes) was added by, to School of Mines, 452–456.

Portion of School of Mines' fees reserved by, 484.

Expenses of School of Mines and College of Chemistry borne by, 490–492, 504.

Appointments in College of Chemistry made by, 505.

Government departments might save by having their work done in the School of Mines' laboratories, if there were sufficient accommodation, 519, 549.

College of Chemistry is a Government institution, 557.

REEKS, TRENHAM, Esq.—cont.

*Guthrie, Professor.*

Forty lectures on physics delivered by, to School of Mines' students, 365.

*Huxley, Professor.*

Eighty lectures on natural history delivered by, to School of Mines' students, 365.

Allusion to remark by, on want of laboratory accommodation in Jermyn Street, 401.

*India.*

School of Mines' students recommended for appointment on Geological Survey of India, 436.

Dr. Percy's certificates are accepted in appointments to Indian mints; many Indian officers study at School of Mines to obtain these, 496, 497, 520.

*Inland Revenue Department.*

Officers of, are instructed in College of Chemistry, 516–518. Other Government departments might follow this plan, 519.

*Jermyn Street Institution.*

Building erected by Government, and one contiguous house rented, 410–412. It would be difficult to sell, 413.

Laboratories in, are inefficient, 416, 417.

History of the connexion of the College of Chemistry with the institution, 452–457.

Building constructed according to ideas of Sir H. De la Beche, whose great notion was the application of chemistry to agriculture, 464–466.

See *Royal School of Mines.*

*King's College.*

Boarding-hall for students in connexion with, 513–515.

*Laboratory (Biological).*

Allusion to remark on want of, by Professor Huxley, 401.

No biological laboratory contemplated when museum in Jermyn Street was built, 471.

*Laboratory (Chemical).*

The Royal College of Chemistry is the laboratory of the School of Mines, 399, 400. Inefficiency of this laboratory, 415–417.

Original laboratory in Jermyn Street found too small; College of Chemistry added, 452–457.

The upper laboratory in Jermyn Street (now Dr. Percy's) was built for instruction in agricultural chemistry, 469.

See *Royal College of Chemistry.*

*Laboratory (Metallurgical).*

Inconvenience of the laboratory in Jermyn Street, 400, 417, 539.

Students enter for short periods and for special purposes, as assaying of gold, silver, &c., 419.

No metallurgical laboratory originally provided in Jermyn Street, 470.

*Lectures (Royal School of Mines).*

Are both general and special, 363, 364. Enumeration of subjects, 365.

Students can enter for the whole, or for one or more courses, 366. The greater number do not attend all, 374, 375.

Attendance at lectures essential to attainment of certificate, which is awarded after examination following each course, 367–371.

Except mining, &c., the lectures are such as might be given elsewhere, 442.

Fees paid for, by occasional students, &c., 531.

Special evening courses for artisans; great demand for tickets, 534–537, 559–565. All the subjects are lectured upon in turn to working men, 564, 565.

Evening lectures at 5s. the course have also been established; not so successful as the working men's, 560–563.

*London.*

Dislike of manufacturers, &c. to send their sons to London, 475. Parents might send their sons to School of Mines, &c. if they could find a proper home for them, 513–515.

*Manufactures.*

Larger income to be derived from, than from science teaching, 447.

Reasons why proprietors of, do not send their sons to London for instruction, 475.

*Maps (Geological Survey).*

Publication of, impeded for want of office room, 408.



REEKS, TRENHAM, Esq.—cont.

*Mathematics.*

Want of mathematics in School of Mines' teaching has been represented to Government; few students come prepared with mathematical knowledge, 430-433, 540, 541a.

An associate of School of Mines can obtain a certificate without a knowledge of mathematics, 566.

*Matriculation.*

None at School of Mines, 394.

*Mechanical Drawing.*

Twenty lessons in, are given to School of Mines' students, 365.

*Metallurgy.*

A special subject at School of Mines, 363, 377, 553-556. Fifty lectures on, delivered to students, 365.

Many former School of Mines' students are engaged in metallurgy, 378. Lucrative appointments held by exhibitors, 392, 448, 480-482.

Inconvenient laboratory for, at Jermyn Street, 417, 539.

Assaying of gold, silver, &c. specially studied by many School of Mines' students, 419.

No laboratory for teaching metallurgy originally provided in Jermyn Street, 470.

Dr. Percy's certificates in, accepted for Indian mint appointments, 496, 497, 520.

Duties of professor of, in Royal School of Mines, 506-508.

*Mineralogy.*

Forty lectures on, delivered to School of Mines' students, 365.

*Mining.*

Metallurgy, mining, and geology special subjects at the School of Mines, 363, 377.

Sixty lectures on, delivered to School of Mines' students, 365.

School of Mines will compare favourably in number of students with the mining schools at Paris and Freiberg, 543-546.

*Murchison, Sir R. I., Bart.*

Recommends School of Mines' students for appointment on home and colonial geological surveys, 435-437, 520-522.

*Museum of Practical Geology.*

The School of Mines arose out of the Museum and Survey; value of Museum in illustration of lectures, &c., 362, 404, 405.

The rooms in, now employed as offices, ought to be for exhibition of specimens, 408.

Built for a special purpose, according to the ideas of Sir H. De la Beche, 413, 457-472.

*Natural History.*

Eighty lectures on, delivered to School of Mines' students, 365.

*Oldham, Professor.*

On request of, School of Mines' students are recommended for Indian Geological Survey, 436.

*Peel, Sir Robert.*

Allusion to interest taken by, in chemistry and agriculture, at the time of building the museum in Jermyn Street, 466.

*Percy, Dr.*

Fifty lectures on metallurgy delivered by, to School of Mines' students, 365.

His upper laboratory in Jermyn Street was originally constructed for teaching agricultural chemistry, 469.

Allusion to his register of School of Mines' students engaged in metallurgy, &c., 482; and to inefficient metallurgical laboratory, 539.

His certificates are accepted in Indian mint appointments, 496, 497.

See *Metallurgy*.

*Physics.*

Forty lectures on, are delivered to School of Mines' students, 365.

*Playfair, Dr. Lyon.*

College of Chemistry added to School of Mines by arrangement with, 452.

Allusion to attention paid to agricultural chemistry by, 469.

*Practical Instruction.*

Deficiency in, shown by students on entering School of Mines, 473-477.

Practical following theoretical instruction is the plan proposed by School of Mines' prospectus, 478, 479.

In the case of the Inland Revenue officers who attend the College of Chemistry, the practical instruction is learned in their own departments, 518.

REEKS, TRENHAM, Esq.—cont.

*Ramsay, Professor.*

Delivers 36 lectures on geology to School of Mines' students, 365.

*Royal College of Chemistry.*

Is the laboratory of the School of Mines, and the property of the Government, 399, 414.

Students have been refused there for want of room, 415, 538.

The laboratories are not equal to requirements of present day, 416, 417.

History of its connexion with School of Mines; the laboratories at Jermyn Street were too small, and the college (then in difficulty) was added to the institution, 452-457.

Laboratory expenses in, except lighting and fuel, paid by professors, 499.

Is only bound to educate associated students of School of Mines; other students may be taken, 501-503.

Entirely merged in School of Mines; appointments in, are made by department, 505.

Students sent to, by Inland Revenue, to attend lectures, and be examined before appointment, 516-518.

With more accommodation, the work now done for the Inland Revenue might be extended to other Departments, 519, 549, 550.

Has no private support, 557.

*Royal Exhibitioners.*

Government keep nine at School of Mines; they are selected at the May examinations of the Department, 390, 391. Most get lucrative appointments, chiefly metallurgical, 392, 448, 480-482.

Subsistence money for, is charged to account of School of Mines, 445, 446.

*Royal School of Mines.*

Witness is registrar of, 359.

The officers of, are, a director, seven professors, two assistants, and a registrar, 360.

Established to promote mining industry, by lectures to students, &c., and by a public museum; the school was founded upon the museum, 361, 362.

Title of, has been several times altered, with prejudicial effect, 396-398.

The College of Chemistry is the laboratory of the school, 399.

Desire for more accommodation in, has been expressed by professors, 400-402.

Some professors in, might agree to removal of school to South Kensington; no serious objection against removal has been raised, 420-422.

Want of mathematical instruction in, 427-433, 540, 541a.

Appointments obtained from, by students and others, 434-439, 447, 493-498, 520-530.

Cost of School of Mines' students; also of professors, prizes, &c., 443-446, 449-451.

History of connexion of College of Chemistry with, 452-457.

Jermyn Street building not originally constructed for a school of mines; the school was an experiment, 457-472.

Reasons why manufacturers, &c. object to send their sons to School of Mines; one reason being the difficulty of finding a home for them, 475, 513-515, 542-544.

Theoretic instruction, and afterwards practical application, is the system proposed in School of Mines' prospectus, which is prepared by the professors, 478, 479, 547.

Division of fees in, 484, 485.

Professors of, are provided with assistants, apparatus, &c. Grant for this found to be adequate, 486-492.

Students receive whatever patronage is at disposal of school, 493, 495.

College of Chemistry is only bound to educate associated students of School of Mines; it is entirely merged in the school, 501-503, 505.

Duties of metallurgist and chemist in, 506-512.

Besides the Inland Revenue, other departments might benefit by work done in School of Mines' laboratories, if they were larger, 519, 549, 550.

The school is governed by the director and the professors, subject to the Lord President, 547, 548.

The Survey is facilitated by choosing officers trained in School of Mines, 551, 552.

Metallurgy is a special department in the school, 553-556.



## REEKS, TRENHAM—cont.

*Royal School of Mines' Students.*

Enumeration of subjects of lectures given to, 362-366.

A certain number of lectures must be attended to gain a certificate, 367, 368.

Students are examined at end of each course, and awarded certificates according to merit, 369-371.

Number of, for 1869-70, was 103; the average for past ten years is 111, 372, 373, 382, 383, 387.

Greater number attend on the average three courses, 374, 376.

Many attend for special objects, as miners, metallurgists, chemists, brewers, &c.; others with the view of getting on the Geological Survey, &c., 377.

A large proportion are ultimately engaged in mining and metallurgy, 378.

Those who enter for three years pay 20*l.* two successive years, or one sum of 30*l.*; there are also laboratory fees, 379, 483.

No limit of age for; the average perhaps is 18 to 24, 380.

About 14 per annum enter for, and continue during, the whole course, 382, 385, 386.

Government keep nine free students, selected at the May examinations; they are of superior ability, and get lucrative appointments, chiefly metallurgical, 390-392, 448, 480-482.

No matriculation for, 394, 423.

Number of students in metallurgical laboratory; many come for short periods, and special objects, 417-419.

First two years study of, is preparatory; the third devoted to subjects in which they wish to become associates, 424-426, 440, 441.

Examinations on every subject must be passed by students to gain associateship; to obtain certificates they must pass examination at close of each course, 427-429.

Most enter deficient in mathematical knowledge; a preliminary examination might exclude many; a professor of mathematics wanted, 431-433, 540-541*a*.

Appointments obtained by, on the home and colonial geological surveys, 434-439, 493, 495, 520-530.

Cost of, to the State. A large item in expenditure of the school is for Government free students; these do not generally become science teachers, 443-447.

Students mostly enter the school without any previous practical training, 473, 474.

Students receive whatever patronage is at disposal of the school, 493.

Certificate of Dr. Percy held by, is accepted in appointments to mints of India, 496, 497.

College of Chemistry only bound to educate associated students, 502.

Want of a home in London for, 513-515.

Inland Revenue students, 516-518.

Fees paid by occasional students, army and navy officers, certificated schoolmasters, &c., 531.

Students are of various classes; not the artizan class, 532, 533.

An associate can obtain a certificate without a knowledge of mathematics, 566.

*Science and Art Department.*

Free students of the School of Mines are selected at the May examinations of, 390-392, 448, 480-482.

Appointments in College of Chemistry are made by, 505.

*Science Teachers.*

School of Mines' free students do not generally become science teachers, 447.

*Staffordshire.*

Half the coal of, stated to have been lost through want of scientific knowledge, 482.

*Samuelson, Mr.*

Reference to committee of, 373, 516.

*Smyth, Mr.*

Delivers 60 lectures on mining, and 40 on mineralogy, to School of Mines' students, 365.

*South Kensington.*

Removal of School of Mines to, would be a choice of two evils. Were certain classes held at South Kensington, there would be some, but not insuperable, inconvenience, 403-406. Certain professors would acquiesce in removal; no serious objection against it has been raised, 420-422.

*University College.*

Boarding-hall for students in connexion with, 513, 514.

26060.

## RAMSAY, PROFESSOR, LL.D., F.R.S. (Index of his Evidence.)

*Accommodation for Science Purposes.*

No want of, as regards School of Mines, 667.

Office room wanted for the Geological Survey; proposals that have been made. Stoppage of work for want of room, 669-674, 695.

More room wanted for geological specimens in museum, 670. The museum would suffer, even if the School of Mines' lecture-halls, laboratory, &c. were appropriated to Survey purposes, 677.

The present Survey offices were originally intended for the museum, 678.

*Agriculture.*

Farmers are becoming aware of the importance of geology with regard to soils, 754.

*Associates of the Royal School of Mines.* See *Royal School of Mines' Students*.

*Black Board.*

Every teacher of geology should be able to illustrate his teaching with chalk and a black board, 619.

*Cambridge University.*

Geology has been well taught at, by Professors Sedgwick and Stokes, 687.

A practical mining student might qualify at Cambridge, with the advantage of Professors Sedgwick and Stokes' teaching in geology and physics; but there is no professor of mining there, 713.

*Canada.*

Many gentlemen from, have attended the courses of the School of Mines, 656. The directors, former and present, of the Geological Survey of Canada, were both trained on the British Survey, 757 (*additional remarks*).

*Cape of Good Hope.*

The former conductor of the Geological Survey of the Cape was trained on the British Survey, 757 (*additional remarks*).

*Chairs of Science.*

No special chair of geology in Scottish universities, 686.

Defective teaching from geology forming a branch only of natural history chair, 687.

Professor Huxley's chair in Jermyn Street is Natural History and Palaeontology; the latter an essential subject in a school of mines, 691.

See *Endowment*.

*Chemistry.*

An ultimate reference to practical chemistry would not affect the character of the School of Mines, 734.

Is taught in every laboratory; and competent teachers are plentiful, and turn out a large number of able young men, 748.

Want of a practical chemist on the Geological Survey; the School of Mines' professors of chemistry and metallurgy not being bound to do work for the Survey, 751-753.

*Children.*

Some of the candidates in geology appear to be mere children, 569, 576.

Geology may be taught to children at an early age, 605.

Desirability of imparting theoretical knowledge of geology to children, 631.

*Civil Engineering.*

The School of Mines' courses would be desirable for a person intending to follow civil engineering, 750.

*Coal.*

Valuable service rendered to coal-mining industry by Geological Survey, 703-706. Unless theoretic science can apply means of ventilation, a great quantity of coal will never be won, 707, 708.

Government has ordered the Geological Survey to re-survey all the coal-fields on maps of six inches to a mile, 754.

*Colonies.*

Many of the former students of the School of Mines and officers on the English Survey have been engaged in the geological surveys of the colonies, 741.

*Cornwall.*

Memorial from mining people in, to Government, to establish a mining institution, 702.

*Cramming.*

This practice is shown in Department examinations in geology, 569. Evidences of cramming are pointed out, 632.

*De la Beche, Sir Henry.*

Attention of, called to want of office accommodation for Geological Survey at Jermyn Street, 674.



## RAMSAY, PROF.—cont.

*Denbighshire.*

Desire of mining proprietors in, to have geological maps on the six-inch scale, 754.

*Deron.*

Memorial from mining people in, to Government, to establish a mining institution, 702.

*Drawing.*

Candidates in geology seem to have no notion of drawing, 621.

*Elementary Education.*

Want of, shown by many candidates in geology, 569.

*Elementary Schoolmasters.*

They might be able, in addition to their ordinary daily duties, to teach geology with somewhat satisfactory, though imperfect, results, 614.

*Endowment of Chairs of Science.*

The sciences taught at the universities do not remunerate the professors; fees are insufficient. To get good men there should be an endowment of chairs, 687, 688.

It would be better to endow chairs, first in independent institutions, and if found insufficient, Government might establish new ones, 689.

A professorship of mining might be endowed in University College, &c., if the man and the money could be got, 727; but it would be difficult to establish a mining school with the means and appliances in Jermyn Street, 728, 729.

*Engineering Students.*

Obliged to attend geology course at King's College, 687.

*England.*

Geology is better taught in England than in other parts of the United Kingdom, 590.

Progress of the Geological Survey in. The Ordnance Survey has only been finished this year, 754.

*Exhibitioners of the School of Mines.*

Are sent by Government, after a difficult Department examination. Their abilities correspond with what might be expected, 661.

*Flintshire.*

Desire of mining proprietors in, to have geological maps on a six-inch scale, 754.

*Fossils and Rock Specimens.*

Department candidates in geology show little evidence of having been taught from, 602, 615.

Children should be taught geology by the use of, 600.

*Gould, Mr.*

Directed the Geological Survey of Tasmania. He was trained in the School of Mines and on the British Survey, 757 (*additional remarks*).

*Geological Maps, Sections, and Specimens.*

The way to acquire a practical knowledge of geology is to work over the country with geological maps and sections in hand, 626, 627.

Want of room for exhibition of geological specimens in Museum of Practical Geology, 670.

*Geological Survey of the United Kingdom.*

Witness has the direction of the Geological Survey of England and Wales, 668.

Want of office room for, in Jermyn Street, 669, 670.

Proposals to meet the difficulty. Stoppage of work for want of room. Greater space allotted to Survey offices in Scotland and Ireland, 671-674.

If the School of Mines' lecture-halls, laboratory, &c. were appropriated to Survey purposes, the museum would still suffer, 677.

The present Survey offices were originally intended for the museum, 678.

If School of Mines were removed, museum and Survey wants would not be supplied, without building; the rooms being ill-adapted as they stand, 679, 680.

Late rapid increase of surveyors, to hasten the entire Survey, 696, 697. When in London they are obliged to work at home and so are under no superintendence, 698.

The Geological Survey was founded in 1834, 700.

Great advantages to miners derived from the published maps of the Geological Survey. Valuable services rendered to the Coal Commission by the Survey, 703-706.

The Survey has often given advice with respect to water supply of towns, 706.

The best collections in the museum were made by the experienced officers of the Survey, 730, 731.

RAMSAY, PROF.—*Geological Survey, &c.*—cont.

The School of Mines was established in connexion with the Museum of Practical Geology, not with the Geological Survey, 731.

The Survey difficulty would be met by additional space, and not by separation from the other establishments, 732.

Want of a practical chemist attached to the Survey; professors of metallurgy and chemistry in School of Mines not bound to work for Survey, 751-753.

Detailed statement of the progress of the Geological Survey, 754.

Witness highly approves of the re-survey on a six-inch scale, 755.

The insufficiency of the one-inch map will be remedied in time; but the Survey cannot move from one place to another on account of fresh ground being opened by miners, 756.

The School of Mines and the Geological Survey have formed an important school of geologists, who have been engaged in distant countries. Instances cited, 757 (*additional remarks*).

Opinions of Signor Sella and M. Marcou quoted, showing their high estimation of the British Geological Survey, 757 (*additional remarks*).

*Geology.*

The Department examinations extend a knowledge of geology, although not in a very satisfactory way, 569.

Gradual increase of candidates for examination in geology to 1067, 571. Considerable improvement shown last year, but not this year, 576.

Teachers of geology should have a special training. The teaching is very unsatisfactory in a great part of the United Kingdom, 590.

Geology may be taught to children at an early age, and might be part of a household education, 605, 606. It cannot be taught properly from books, 613.

Geology might be taught by masters of elementary schools, &c. with somewhat satisfactory results, 614, 622.

The geology of their own neighbourhood should be taught to pupils, along with the leading facts of the science, 617-620.

Better hope of good instruction in geology from secondary schools than from most science classes, 623.

Geology should be practically learned, with maps and sections, in the field; but the mind can be prepared to appreciate by lectures, 626-629.

A theoretical knowledge of geology is desirable, even if the practical knowledge be not attained; but, without the latter, no one can teach geology in the highest style, 630, 631, 636, 637.

Anyone may attend the courses in geology at the School of Mines, 640. Many who have so attended have since become distinguished as geologists, 650.

Want of room for exhibiting geological specimens at Jermyn Street, 670-674, 677, 678.

Geology embraces so many sciences, that the more a man knows of them the better; he should be allowed to get his information at the universities, or elsewhere, 682-684.

Defective teaching of geology in Scotland, through the subject forming only a branch of the natural history chairs, and some of the professors not being good geologists, 686.

Geology has been well taught, though not well remunerated, in the universities and colleges of England; remuneration from fees insufficient; endowment of chairs is necessary to get good men, 687-689.

Paleontology is an essential subject in a school of mines, 691.

The number of surveyors has lately been largely increased to hasten the progress of the Geological Survey, 696, 697.

The Geological Survey was commenced in 1834, 700. The maps have been of great service to mining industry, to the Royal Coal Commission, and in connexion with water supply of towns, 703-706.

The best practical teaching is the highest theoretical teaching in geology, 709.

The teaching of geology in the universities (Cambridge excepted) would not lead to such practical results as the teaching in the School of Mines, 710-712.

Those who have entered for geology at School of Mines have been rarely found deficient in preliminary education, 715.

The School of Mines' course comprises 36 or 38 lectures on theoretical geology, the students being sometimes taken for an excursion, 722-724.



## RAMSAY, PROF.—cont.

*Government.*

Students sent to School of Mines by Government after a difficult examination at South Kensington, 661.

Representations to Government on account of want of space for Geological Survey offices in Jernyn Street, and proposition to purchase certain property adjacent, 671-674.

Memorialized by mining people in Cornwall, Devon, &c. to establish a mining institution, 702. Established the School of Mines, 739, 744.

Has ordered the Geological Survey to re-survey the coal-fields on maps of the six-inch scale, 754. Witness highly approves of this, 755.

*Government Grants in aid of Science.*

Saving effected by plucking ignorant pupils, and preventing the teachers getting money for them, 579, 582.

There is as much money spent upon the Geological Survey, and as many officers engaged, as is desirable; but a practical chemist is much wanted, 751.

*Honours.*

There is an honours' class for geology in Department examinations. Last year candidates were all plucked; this year three passed, 573.

*Huxley, Professor.*

His chair is Natural History and Palæontology, the latter subject being essential in a school of mines, 691.

*India.*

Officers of the Indian army attend the lectures on geology, &c. at School of Mines, 656.

Many former students of the School of Mines have been engaged in the Geological Survey of India, 741. The director of the Survey of India was formerly an officer on the English Survey, 757 (*additional remarks*).

*Iron-mining Industry.*

Valuable assistance rendered to, by Geological Survey, 703.

*Jamaica.*

The former director of the Geological Survey of Jamaica was a pupil of the School of Mines, 757 (*additional remarks*).

*King's College.*

Excellent geological teaching has been given at, by Sir Charles Lyell and Professors Phillips, Ansted, &c. More remunerative than University College, by reason of the engineering students being compelled to attend geology, 687.

*Lectures (on Geology).*

The number given on theoretical geology by witness at University College was about 25; at School of Mines now 36 or 38, 718-724. With an endowment at the former place, the same kind of course might be given as at the latter, 720, 721.

Perhaps 50 persons may have attended the day course on geology at School of Mines, 725, 726. There are also courses in the evening, one of which is for working men, at 6d. for six lectures, 725.

The lectures on geology at the School of Mines are the same as those the lecturer might give in a university or college, 733.

After every lecture on geology at the School of Mines witness stays to answer questions, and considers that plan better than any ordinary examination, 735.

*Logan, Sir William.*

Established and formerly directed the Geological Survey of Canada. He was trained on the Survey of Britain, 757 (*additional remarks*).

*London.*

Some good might be effected by bringing teachers of geology to a training college in London, 612, 628.

*Manufactures.*

Witness considers a highly scientific education not essential for the majority of common-place manufactures, 747, 750.

*Maps of the Ordnance and Geological Surveys.*

The maps of the Geological Survey have been of great service to mining industry, 703-705.

Progress of Ordnance and Geological Survey maps of England and Scotland, 754.

The more scientific geological maps are, the more useful they are, 756.

High opinion of Signor Sella and M. Marcou respecting the Geological Survey maps of Britain, 757 (*additional remarks*).

## RAMSAY, PROF.—cont.

*Marcou, M.*

High opinion of, quoted, respecting the work of the Geological Survey of Britain, 757 (*additional remarks*).

*Meeting of Science Teachers.*

Held at Liverpool to condemn the severity of the Department examiners, 635.

*Metallurgy.*

Many applications have been made to School of Mines for persons to fill positions in copper and iron works, &c.; and many students of the school have gone into such establishments, with good salaries, 742.

Professor of metallurgy in School of Mines not bound to work for Geological Survey, 751, 752.

*Mining.*

If a school were situated in a mining district, the teacher should be able to explain the geology of that district, 619.

A good number of persons interested in mining have sent their sons to the School of Mines, 657, 658, 666. The subjects taught in the School of Mines have always had relation to mining and practical matters, 690.

Important assistance to mining industry rendered by the Geological Survey, particularly with respect to coal and iron, 703-706.

Unless theoretic science can apply means of ventilation to mines of great depth, a large quantity of coal will never be won, 707, 708.

The School of Mines' geological instruction is more valuable to a mining student than that of the universities, &c., Cambridge excepted, 710-712.

There is no professor of mining at Cambridge, nor (witness thinks) in any institution in Great Britain, except the School of Mines, 713, 740.

A professorship of mining in University College, &c. might be established, 727. But it would be difficult to obtain the means and appliances there are in Jernyn Street, 728, 729.

The School of Mines was established after memorials addressed to Government by representatives of mining interest of Great Britain, 737.

A good number of former students of the School of Mines are engaged in mining industry, 741, 742.

The Geological Survey are re-surveying the coal-mining districts on maps of the six-inch scale, 754-756.

*Murchison, Sir R. I., Bart.*

Attention of, called to want of office accommodation for Geological Survey at Jernyn Street, 674.

Pressed by the authorities to go on more quickly with the Geological Survey, 696.

*Museum of Economic Geology.*

It was founded in 1838, 699. (See *Museum of Practical Geology*.)

*Museum of Practical Geology.*

Want of room for geological specimens in, 670.

If the School of Mines' lecture-halls, laboratory, &c. were appropriated to Survey purposes, the museum would still suffer, 677.

The present Survey offices were originally intended as a part of the museum, 678.

The Museum of Economic Geology (the precursor of the Museum of Practical Geology) was founded in 1838, 699. The collections were first deposited in Craig's Court, afterwards in present museum. The School of Mines was established in connexion with the museum, not with the Geological Survey, 731.

*Natural History.*

Defective teaching of geology in Scotland, through its being included in the natural history chair, 686.

Professor Huxley's chair in School of Mines is Natural History and Palæontology; the latter an essential subject in a school of mines, 691.

*Oldham, Professor.*

Director of the Geological Survey of India. Was formerly an officer on the Survey of Britain, 757 (*additional remarks*).

*Ordnance Survey.*

Has only been finished in England this year, and is still behind in Scotland, 754.

*Oxford University.*

Geology has been well taught at, by Professors Buckland, Strickland, and Phillips, 687.

*Palæontology.*

An essential subject in a school of mines, 691.

*Practical Instruction.*

Geology cannot be properly taught, except by a teacher who has had practical experience, 590, 613.



RAMSAY, PROF.—*Practical Instruction*—cont.

Very little evidence of practical instruction shown by candidates in geology at Department examinations, 601, 602, 615, 616.

Children at an early age might begin to learn geology by aid of specimens, &c., 606.

A teacher of geology should be competent to instruct students in the geology of their own neighbourhood, 617-620.

Practical knowledge of geology may be obtained by working over a country with maps and sections in hand, 626, 627, 629.

Theoretical instruction in geology is valuable, if practical instruction be not attainable, 630, 631, 636, 637.

Most of those who attend the lectures on geology at the School of Mines have a practical end in view, 656. The teaching has always related to mining and other practical matters, 690.

No good practical instruction which does not involve high theoretical instruction, 709.

The geology taught in the universities (Cambridge excepted) would have less practical results than the teaching of the School of Mines, 710-712.

*Royal Coal Commission.*

Important service rendered to, by Geological Survey, 703-705.

*Royal School of Mines.*

Witness is professor of geology in, 638. Is perfectly satisfied with the present regulations of his department, and does not recommend any alteration, 651, 652.

No entrance examination in, for general students. Approval of this system, 663-665.

No inconvenience in, for want of room, 667.

If the lecture halls, laboratory, &c. of, were appropriated to the Survey offices, and the present Survey offices also retained, the museum would still suffer, 677.

Even if School of Mines were removed there would not be room for museum and Survey purposes without building, 679, 680.

It was founded as a school of mines; the subjects taught have special relation to mining and other practical matters; and it resembles the continental schools of mines, 690-694.

Professor Huxley's chair in, is Natural History and Palæontology; the latter subject essential in a school of mines, 691.

It was founded in 1851, 701. Mining people from Cornwall, Devon, &c. memorialized the Government for its foundation, among them being Sir Charles Lemon and Mr. John Taylor, 702.

Operations of, not independent of the aid to be derived from the resources of experimental science, 707-709.

The teaching of geology in the universities (with the exception of Cambridge) would not lead to such practical results as that of the School of Mines, 710-712.

About 36 or 38 lectures form the course on geology, 719. Students are sometimes taken for an excursion. The lectures are on theoretical geology, 722-724.

It would be difficult to establish a mining school with the means and appliances at Jermyn Street, 728, 729. The School of Mines was established, with all the advantages accruing from the Geological Survey, the museum, and the mining collections in connexion with it, 731.

The difficulties of the Geological Survey would be relieved by more space, and not by the separation of the establishments, 732.

The lectures on geology at the School of Mines are the same as might be given in a university, 733. Examinations are all written, 735. After each lecture witness stays to answer questions, which he conceives better than an ordinary examination, 736.

Its character would not be affected by an ultimate reference to practical chemistry, 734.

The School of Mines arose out of the representations of a powerful commercial interest, 737-739. The Government considered the establishment of the school fully justified, 744. Established because there was not that combination of lectures existing elsewhere, 738.

Witness thinks there is no professor of mining in any other institution in Great Britain, 740.

Many applications are made to School of Mines for persons to fill positions in copper and iron works, &c., 742.

Combination of studies at, is desirable for a person intending to follow civil engineering, 750.

The professors of metallurgy and chemistry in, are not bound to do work for the Geological Survey; a chemist is wanted for the Survey, 751-753.

RAMSAY, PROF.—*Royal School of Mines*—cont.

Distinguished geologists who have conducted colonial geological surveys, and who were formerly students in the School of Mines, or officers in the Geological Survey of Britain, 757 (*additional remarks*).

*Royal School of Mines' Students.*

Students desirous of becoming associates must attend the lectures on geology. Others may also attend, 639, 640. The number attending is not large, 641.

The course is comprised in one year, and students take it in their second year, 641-643.

They are examined at the close of the course; formerly three times, but now only once, 644, 645. Others who attend the course may undergo examination; the younger ones do, 646, 647.

Many of the students are middle-aged, and even old, 648, 649.

Many who have entered for associateship have passed high examinations, and become distinguished, 650, 653. Others who have voluntarily attended have written good papers on geology, &c., 654.

Some attend for their own gratification; most have a practical end in view. Gentlemen home from India, &c. attend, that they may apply the information they gain on their return, 655, 656.

The Turkish Government, Italy, Canada, the United States, &c. have sent students, 656.

A great number have been sent from mining districts; these more frequently come as associated students, 657, 658, 666.

Some students have become teachers; one of them, Mr. Blanford, is professor of geology in Calcutta, 659, 660.

There are some who enter after a difficult examination at South Kensington; these show ability, 661, 662.

There is no entrance examination for general students. Approval of this system, 663-665.

All do not enter the school to learn mining specially, but to attend the courses generally, 692-694.

Gain more practical results in geology than those who attend courses at universities, &c., 710, 711. Cambridge excepted, 712.

Have rarely entered in geology without sufficient preliminary education, 715.

About 36 or 38 lectures on geology are given, 719.

They are theoretical lectures, but the students are sometimes taken for an excursion, 722-724.

Perhaps as many as 50 may have attended the geology course, 725, 726.

Many former students are employed in mining industry, and in geological surveying in India, &c.; some have grown rich by the knowledge they obtained at the School of Mines, 741, 742.

*Schools.*

Desirability of imparting theoretical knowledge of geology to boys in schools, 605, 631.

*Science and Art Department.*

Witness has acted as examiner in geology to the Department from the beginning of the system, 567, 568.

The Department system is extending a knowledge of geology, but many teachers appear to be unqualified, and many candidates too young, 569.

Men are sent by Government to School of Mines after undergoing a difficult Department examination, 661.

Report sent to, this year, by examiner in geology, of specially bad candidates, 583.

Repeated notice to, of want of any notion of drawing, and ignorance of the strata in their own neighbourhood, shown by candidates in geology, 621.

Evidences of cramming are pointed out to, 632.

The Department knows from what schools the examination papers come; the examiners do not. Approval of this system, 633, 634.

*Science Classes.*

Better hope of instruction in geology from secondary schools than from science classes, 623.

*Science Examination Papers (in Geology).*

Many show great want of elementary education in candidates, and signs of cramming, 569. Evidences of cramming, &c. shown in, are pointed out to Department, 583-632.

Papers are tied up in numbered bundles, and do not show where candidates come from, 584. The Department knows, the examiners do not, 633, 634.

*Science Examinations (in Geology).*

Tend to spread a knowledge of geology; but show that some teachers are unqualified, and some candidates too young, 569, 603, 604.

Candidates increase in number; this year there were



RAMSAY, PROF.—*Science Examinations, &c.*—cont.

1,067. More than one half were plucked, and most of the others passed in the elementary stage; three passed with honours, 572, 573.

Considerable improvement was shown last year, but not this year, 576.

Where examinations show that schools are not doing efficient work, pupils must be plucked strictly, 579.

Show that many candidates are quite unacquainted with the subject, 581. Very bad cases are reported to Department, 583.

All the papers from, are reviewed by examiner, or by his assistant; in the latter case being checked by examiner 594–599.

Show the instruction to be chiefly derived from books; a few only going into the field, or collecting fossils, 601, 602, 615, 616.

In some cases the locality may be inferred from whence the papers come, by descriptions of certain districts, 610.

Want of a knowledge of drawing, and of the geology of pupils' own neighbourhood, shown by, 621.

Cases of cramming shown by, will always be reported by witness to Department, 632.

There is no entrance examination for general students at School of Mines. Approval of this system, 663–665.

At School of Mines, examinations in geology are entirely by writing. After every lecture witness stays to answer questions, and conceives that plan better than any ordinary examination, 735.

*Science Examiner (in Geology).*

Witness has been examiner in geology to Department since beginning of system, 567, 568.

Great trouble entailed on, by ignorant candidates, 582. Report of these sent this year to South Kensington, 583.

Examiner does not know where the candidates come from, 584. May sometimes infer it from descriptions of geology of certain districts, 610.

Witness examines all the papers, but is allowed an assistant when they are over 1,000; he checks, and is responsible for, the work of the assistant, 594–599.

Witness always points out to Department evidences cramming, 632.

Does not know from what schools the examination papers come. Approval of this plan, 633, 634.

Witness was condemned once for severity in Department examination by a meeting of science teachers at Liverpool, 635.

*Science Examiner (Assistant).*

Where more than 1,000 papers, assistant allowed to chief examiner, who checks, and is responsible for, his work, 594–599.

*Science Students (of Geology).*

Many candidates are too young and imperfectly educated to undergo Department examination, and are crammed by their teachers, 569, 603, 604. Number of candidates, and results of examination, 571–573.

They may confide up for examination without having had any instruction from science teachers, 574.

When bad, must be plucked strictly, 579.

Many are quite unacquainted with the subject, 581–584. Are instructed from books, but in a few instances seem to have collected fossils, &c., 601, 602, 615, 616.

Geology may be begun by children at a very early age; they should be instructed in the geology of their own neighbourhood, as well as in the leading facts of the science, 605, 606, 617–619.

They should be taught to use the chalk and black board, 619.

No Department candidates show any notion of drawing, or of understanding the geology of their own neighbourhood, 621.

May learn a great deal by working over the country with maps and sections, 626–629.

Evidences of cramming shown by, are pointed out to Department, 632.

At King's College, the engineering students are obliged to attend geology, 687.

*Science Teachers (of Chemistry).*

Competent teachers of chemistry are plentiful, and turn out a large number of able young men, 748.

*Science Teachers (of Geology).*

Some appear to have got their knowledge from self-cramming, and then to have crammed their pupils, 569. This does not apply to a large proportion of institutions, 570.

Candidates may come up without having been instructed by science teachers, 574.

RAMSAY, PROF.—*Science Teachers (of Geology)*—cont.

Many teachers are not qualified to instruct in geology, 577.

Inefficient pupils must be strictly plucked, and then their teachers will get less remuneration, 579–581, 608.

Teachers of geology should have a very special training, 590.

Presumption that teachers send up improper candidates in the hope that they may pass, and obtain payment, 607.

Good might be effected among a proportion of the teachers by bringing them to London for instruction, 612.

Failures may proceed from the teacher not being aware that geology cannot be taught from books, 613.

Masters of elementary schools might instruct in geology with somewhat satisfactory, though imperfect, results, 614.

Specimens appear to be little used by the teachers of geology, 615.

A teacher should be competent to instruct in the geology of his own neighbourhood, 618–620.

Essential that the teacher should be able to illustrate his teaching with chalk and black board, 619.

A considerable number of teachers are competent, but not as a general rule, 621.

Teachers might acquire practical knowledge by working over the country, with maps, &c., 626, 627. But they may be prepared by lectures, 628.

With other teachers, held a meeting in Liverpool, to condemn the severity of the examiners, 635.

Without a practical knowledge, they cannot teach geology in the highest style, 637.

A teacher of geology should have a knowledge of general science; rare to find a geologist perfect in any other science, 682, 683. There are establishments about the country where he could study general science, 684–686.

No place in Scotland where teachers could be thoroughly taught geology, 686.

*Scientific Education.*

Not essential to the majority of common-place manufactures, 750.

*Scotland.*

No place in, where geology is thoroughly taught. No chair of geology at universities, it being included in chair of natural history, 686.

Progress of the Geological Survey in. The Ordnance Survey is still far behind, 754.

*Secondary Schools.*

More hope of geology being properly taught by secondary schools than by most science classes, 623.

*Self-instruction.*

Many people (some of a very humble condition) have acquired a good knowledge of geology by self-instruction, 629.

*Sella, Signor.*

High opinion of, quoted, respecting the British Geological Survey maps, 757 (*additional remarks*).

*Selwyn, Mr.*

Director of the Geological Survey of Canada, and formerly of that of Victoria. Was trained on the English Survey, 757 (*additional remarks*).

*Shuttleworth, Sir James Kay, Bart.*

Allusion to men in humble life known by, who had acquired great practical knowledge of geology, 629.

*South Kensington.* See *Science and Art Department*.*Staffordshire.*

Desire of mining proprietors in, to have geological maps on the six-inch scale, 754.

*Tasmania.*

The director of the Geological Survey of, was trained in the School of Mines and on the British Survey, 757 (*additional remarks*).

*Theoretical Instruction.*

Theoretical instruction in geology insufficient; practical, essential, 590, 601, 602, 606, 613, 615–620; theoretical knowledge is of a certain value, 622, 630, 631, 636, 637.

No good practical, which does not involve theoretical, teaching, 709. Witness's lectures are theoretical lectures upon geology, 723, 724.

*Training College.*

Study in a training college in London would prepare a man for understanding geology in the field, 628.

*Trinidad.*

The former director of the Geological Survey of, was a pupil of the School of Mines, 757 (*additional remarks*).



## RAMSAY, PROF.—cont.

*Universities of England.*

Geology has been well taught in, by Profs. Buckland, Sedgwick, &c.; fees insufficient to remunerate the professors; endowment of chairs wanted, 687, 688.  
A mining student would gain less from geology taught at universities, &c., than from that taught at School of Mines, 710, 711. Cambridge an exception, 712.  
No professor of mining in, 740.

*Universities of Scotland.*

Defective teaching of geology in, through that subject being included in the natural history chair, 686.

*University College.*

Geology has been well taught at; but with insufficient remuneration, 687, 718. Witness's course there comprised about 25 lectures, 718.  
If an endowment for geology had been made at, the same kind of course might have been given as at School of Mines, 720, 721.

*Victoria.*

The former director of the Geological Survey of, was trained on the British Survey, 757 (*additional remarks*).

*Wales.*

Progress of the Geological Survey in, 754, 756.

*Wall, Mr.*

Directed the Geological Surveys of Trinidad and Jamaica. He was trained in the School of Mines, 757 (*additional remarks*).

*Water Supply.*

The Geological Survey has often given advice respecting the water supply of towns, 706.

*Working Men.*

Allusion to men in humble condition who have instructed themselves well in geology, 629.  
Courses of lectures to working men at School of Mines; the fee being 6*d.* for six lectures, 725.

*Wylie, Mr.*

Conducted the Geological Survey of the Cape. Was trained on the British Survey, 757 (*additional remarks*).

## FRANKLAND, PROFESSOR, Ph.D., F.R.S. (Index of his Evidence.)

*Abel, Mr.*

Chemical director at Woolwich, and perfecter of the manufacture of gun-cotton; was trained in Royal College of Chemistry, 5683.

*Aberdeen University.*

Professors of chemistry in, trained in Royal College of Chemistry, 5683.

*Accommodation for Science Purposes.*

Want of, at College of Chemistry, 5690, 5693, 5732, 5733, 5688–5693. In Jermyn Street, 5836. At Royal School of Mines, 5734.

*Ages of Science Students.* See *Elementary Schools.**Ammonia Bases.*

Importance of Dr. Hofmann's researches on, in laboratories of College of Chemistry, 5682.

*Analysis.* See *Chemical Analyses.**Aniline Colours.*

Discovered by students in laboratories of College of Chemistry, 5682, 5683.

*Apparatus (Chemical).*

Students at College of Chemistry have to find their own, 5718.

*Brewers.*

Almost constant succession of students sent to College of Chemistry by, 5834.

*Calico Printing and Dyeing.*

Instances of advantage of a knowledge of chemistry as applied to business of, 818–827.

*Chemical Analyses.*

Great deficiency of knowledge of systematic qualitative analysis in candidates examined, 766.  
Expense of, as made for royal commissions and public offices, might be saved by the proposed training college of science, 5768–5772.  
Toxological inquiries for judicial decisions should not be undertaken at proposed training college, 5773, 5774.

## FRANKLAND, PROF.—cont.

*Chemical Research.* See *Chemistry.**Chemistry.*

The Science and Art Department examinations are of value in promoting primary teaching of experimental science, 762, 763.

Number of Department examinations in, in 1868 and 1869; percentages of success and failure; extracts from reports thereon; allowance for laboratory expenses; number of examinations in 1870, with percentages, 766.

Improved character of instruction in, in 1870, 767.

The teaching of, a matter of cramming, unless accompanied by laboratory instruction, 776, 777.

Number of teachers of, who came last year to Oxford Street, 778–783. Proposed increase in numbers this year, 784, 785.

Want of systematic training of teachers in; complaints thereupon; no definite conclusions arrived at by Department on the subject, 786, 787.

Laboratories for instruction of teachers in, intended at South Kensington; separate for different grades; their construction delayed, 788–791.

Elementary chemistry should be taught throughout the country, the best pupils being selected for higher instruction; if the alternative be necessary, advanced instruction should be developed, 793, 794. A supply of elementary pupils by voluntary efforts being contemplated, 803, 804.

The system of examination carried on by the Department draws out self-taught ability, 795–800.

Theoretical knowledge only, without experimental knowledge, is to be judged from examination papers; the inference being that the number practically instructed is small, 806–809.

Elementary instruction in, would afford facilities to remarkable self-educated men which it would be unwise to abandon, 810–812.

Instances cited of the advantages of a knowledge of, in the dyeing business, 818–827.

Several schools of science visited where advanced chemical knowledge can be acquired, 829–831.

Instruction of workpeople superior in Germany and Switzerland to that in England and France; instruction in chemistry given to workmen in Rouen on Sunday, 832–835.

Several important branches cannot be taught at College of Chemistry for want of space, 5690.

Fees for instruction in chemistry ought to be lower in a Government than in a private institution; any impulse given to the study would be beneficial, 5714–5720.

College of Chemistry pays more attention to applications of chemistry to manufactures, and to chemistry as a speciality, than any other institution where the instruction has to be guided with reference to classes of students, 5728–5730.

Of those who came up to College of Chemistry last year for instruction in teaching science, many possessed considerable knowledge of theoretical chemistry, but were deficient in practice. They were not fair specimens of teachers throughout the country, and were selected as having some knowledge of chemistry, 5739–5748.

The classes for teachers in, and laboratory instruction given to them, in College of Chemistry, so far as it went, of great avail, 5754, 5755.

Chemical investigations for royal commissions and public offices might be made at the proposed training college, with saving of expense, 5768–5772. Toxological inquiries with relation to judicial decisions should not be undertaken in the college, 5773, 5774.

A centralization of chemical instruction can only be carried out with partial advantage; some district schools, such as Woolwich, being necessary, 5778.

Practical study of chemistry extremely limited before opening of College of Chemistry, 5782–5787. It may be assumed that the study will increase more rapidly, and that State competition will have no damaging effect, 5788–5791.

In Prussian universities candidates for degree of doctor of philosophy must submit a paper of original chemical research, 5792, 5868. Some such evidence of power should be made indispensable in this country, 5869.

Amount of training necessary to render teachers of elementary schools able to instruct in chemistry, 5793–5799.

Scientific research makes less progress in Great Britain than in France or Germany; damaging effect of the non-recognition of original research on professors and teachers, 5866, 5867.



FRANKLAND, PROF.—*Chemistry*—cont.

Per-centage of papers of original research in chemistry to investigators in Germany, France, Great Britain, &c., 5866.

The work done by students in chemistry depends very much on what is required in examinations, 5869.

Evidence of original power only required in case of candidates for highest degree, 5870, 5871.

A sufficient number of laboratories could not be kept up in this country without assistance from Government, 5875.

Dissertations on original research in, by candidates, in Germany, are usually printed, 5876–5879.

Fellowships given on evidence of original research in chemistry might be given with confidence as to *bona fides*, 5880.

Experiments made in original research in Owens College; Dalton scholarships given for such, 5882.

In buildings proposed to be established for promotion of chemistry, there should be spaces set apart for original investigators; a separate building necessary for study of original research, 5890–5893.

The present condition of teaching in chemistry in the country not generally satisfactory, 5809–5812, 5883–5885.

Similarity of course of instruction in chemistry in laboratories of University and King's Colleges, and some medical schools, with that of College of Chemistry, 5814, 5815.

Special training of teachers of chemistry more the subject for Government interference than elementary training; many who come to College of Chemistry are beginners, 5816, 5817.

Teaching in chemistry should stimulate applications of science to arts, and enable scientific talent to develop itself, 5821.

The majority of students in College of Chemistry have chiefly devoted themselves to technical pursuits, 5822, 5834.

Amount of chemical knowledge that might be taught to boys under 13, 5856–5859.

*Colour Shops.*

A scientific knowledge of chemical manipulation cannot be acquired in; the technical operations carried on in are inconsistent with teaching, 814, 815, 817. Some exceptions to this rule, 816.

A gradual introduction of more scientific methods into colour shops and their laboratories very desirable, 818–821.

Instances of the advantage of chemical knowledge in carrying on the dye trade, 822–827.

*Competition.*

State competition with private institutions will be limited by the extent of State laboratories, and will have no practical damaging effect, 5790, 5791.

Institutions with which College of Chemistry might possibly compete are the laboratories of University and King's Colleges, and those of medical schools which admit chemical students independent of medical students, 5814, 5815.

*Competitive Examinations.*

As now carried on are inimical to the progress of original research in chemistry, 5896.

*Cramming.*

Teaching of chemistry a matter of, unless accompanied by laboratory instruction, 776.

*Dalton Scholarships.*

Given in Owens College, Manchester, for original research in chemistry, 5882.

*Dean.*

Governing body for proposed new training college to consist of dean and council, similar to School of Mines, which works well, 5850–5853.

*Dissertations.*

On original research in chemistry required in Germany from candidates are usually printed, 5876–5879.

Might be required in this country in case of candidates for fellowships, 5880.

In the German universities a dissertation is required from a candidate in any case, 5889.

*Dyeing.*

Instances cited of advantage of a knowledge of chemistry in the business of dyeing, 818–827.

*Elementary Classes and Schools.*

Instruction in elementary classes should be continued, and carried out afterwards in higher institutions, 813.

Teachers of elementary schools should undergo nine months' teaching in science as part of their preliminary training, 5793–5799.

FRANKLAND, PROF.—*Elementary Classes, &c.*—cont.

Amount of chemical knowledge that might be taught in elementary schools to boys under 13; improvement in standard hoped for under the new Education Act, 5856–5862.

See also *Chemistry*.

*Elementary Science.*

The excellent teaching of elementary science in Germany and Switzerland could be well carried out here, if there were effective teachers, 5863, 5864. Because of the method hitherto pursued in this country, elementary teachers are incompetent to treat science, 5865.

Elementary teaching in chemistry is a practical encouragement to those who wish to advance, 804. It would afford facilities to self-taught men, 810–812.

No kind of instruction in science should be discouraged, 813.

*Evening Classes.*

The present teaching of chemistry in evening classes not in a satisfactory condition, 5809–5812.

See also *Elementary Schools*.

*Evening Lectures.* See *Royal School of Mines*.

*Examinations.*

The Department examinations are of value in promoting the primary teaching of experimental science, 762, 763.

Numbers of, in chemistry, in 1868 and 1869, with percentages of success and failure; quotation from report on character of; numbers in 1870, with like percentages, 766. Improved character of, 767.

Questions in chemistry should be so framed as to prevent pupils passing without a knowledge of laboratory instruction, 777.

Candidates may enter for advanced examination in chemistry who have not passed the elementary one, but they cannot take prizes, 768. The rule that candidates pass previously the elementary examination should be continued, 769. Anyone may enter for honours, 770.

The Department examinations develop self-taught ability, 795–800.

Number of marks necessary for candidates to pass, 828. Degrees in science not granted in German universities till after stringent examination, 5792.

The work done by students in chemistry depends greatly on what would be required in examinations, 5869.

Evidence of original power should only be required in case of highest degree. Final examinations for bachelorships in London universities should depend more on experimental knowledge, 5870, 5871.

Examinations for medical degree not of a nature to elicit original research, 5872.

*Examination Papers.*

Great improvement in Department papers in chemistry, 763, 767.

The defects in, show a want of efficient practical laboratory instruction, 766.

Do not show what experimental instruction in chemistry was had by the teachers examined, 805. Theoretical instruction only is to be judged from, 806–809.

On chemistry, organic and inorganic, handed in by witness, pp. 51–53.

*Expenses.*

Government grant in aid of laboratory expenses made in conformity with recommendations, 766.

No expenses of experiments are paid for those who do not pass in experimental chemistry, 767, 768.

Of materials in experiments not covered by fees, 5717, 5718.

Want of funds for expenses a reason for the backward state of chemical scientific research in England, 5867.

Of chemical investigations carried on for royal commissions and public offices might be saved by the proposed Training College of Science, 5768–5772.

Of original research in chemistry should be borne by Government, 5875.

Expenses of special apparatus in College of Chemistry supplied from Government grant, which has sufficed up to present time, 5892, 5894.

See also *Laboratory (Chemical) Expenses*.

*Experimental Instruction.*

The examination papers of teachers show the absence of, 806–809.

*Experiments.*

Want of practical knowledge of experiments the cause of many failures in examinations in chemistry, 766.

Improvement in character of examinations in 1870 due to grant towards laboratory expenses, 767.



FRANKLAND, PROF.—*Experiments*—cont.

Want of funds for, a reason for comparative backwardness of chemical scientific research in England, 5867.  
See also *Chemistry*.

*Fees.*

Scale of fees in Royal College of Chemistry as originally instituted, 5670.  
Amount of, at College of Chemistry; do not include expense of materials; higher at the college than at private institutions; should be lower; and higher than on the continent, 5715–5719.  
Gross aggregate of, received per annum by College of Chemistry, varies from 1,018*l.* to 1,383*l.*, 5823.  
Are complained of as heavy, notwithstanding advantages of passing through College of Chemistry, which are uncertain, 5835.  
College of Chemistry could not maintain itself, notwithstanding the heavy fees payable, 5836, 5837.  
Royal exhibitors at half fees, 5841.

*Fellowships.*

Might be given on evidence of original research in chemistry, with confidence as to *bona fides*, 5880.

*France.*

Per-centage of papers of original research in chemistry to investigators in; less progress in scientific chemical research in Great Britain than in France; reasons for this, 832–834, 5866, 5867.  
Much better supplied with good laboratories than England, 5873.

*Gatty, Mr.*

Of Accrington, instance of, the advantage of knowledge of chemistry as applied to dyeing, 824.

*Geological Survey.*

Proposed disconnexion of, from School of Mines, if College of Chemistry be removed to South Kensington, 5848.

*German Universities.* See *Germany*.*Germany.*

Degrees in science not granted in German universities, till after stringent examination, 5792.  
Per-centage of papers of original research in chemistry to investigators in; less progress in scientific chemical research in Great Britain than in Germany; reasons for this, 832–834, 5866, 5867.  
Much better supplied with good laboratories than England, 5873.  
Dissertations on original research by candidates are usually printed, 5876–5879.  
Little chance of surreptitious proceedings by candidates in universities in, 5881.  
In most of the universities there is only one degree; in some there is a bachelorship, but it is rarely taken, 5886, 5887.  
Conditions on which degrees in philosophy are granted apply to all the Prussian universities; dissertation required in any case, 5888, 5889.

*Government Grants in aid of Science.*

In aid of laboratory expenses in chemistry, made in conformity with recommendations, 766.  
In aid of chemistry, should be in shape of salaries and grants towards expenses of original research, 5875.  
If the annual vote be restricted, encouragement should be given to more advanced instruction in chemistry, a supply of elementary pupils being contemplated from voluntary efforts, 794, 803, 804.

*Government Grant Fund.*

Expense of special apparatus in chemistry supplied from, 5892. Ample for present purpose, 5894.

*Gun Cotton.*

Manufacture of, perfected by Mr. Abel, a student of College of Chemistry, 5683.

*Hofmann, Dr.*

First professor in College of Chemistry; his salary, &c.; succeeded by witness as professor, 5667, 5668, 5680.  
Importance of his researches, in the laboratories of College of Chemistry, on the ammonia bases, 5682.

*Honours.*

Few candidates obtain honours in examinations in chemistry; payments for students who pass in, 766.  
No regulation as to examination for honours; anyone can compete, 770.

*Hoyle and Sons.*

Of Manchester, instances of the advantage of a knowledge of chemistry in calico printing, 822–825.

*Indian Telegraphs.*

Men training for employment on service of, have passed through College of Chemistry, 5831.

## FRANKLAND, PROF.—cont.

*Inland Revenue.*

Chemical analyses made for the Commissioners might be made at proposed Training College of Science, and much expense saved, 5770, 5771.  
Send students to College of Chemistry for instruction, 5777, 5831.

*Inorganic Chemistry.*

Examination papers on, for May 1870, pp. 51, 52.

*King's College, London.*

Professors of chemistry in, trained in Royal College of Chemistry, 5683.

*Laboratories (Chemical).*

Many teachers of chemistry are beginning to fit up, 763.  
Government grants towards laboratory expenses made in conformity with recommendations, 766. Good effects of the measure, 767.

At South Kensington, projected to afford instruction to teachers; separate laboratories for different grades; erection delayed, 788–791.

Amount expended on laboratories, fittings, &c., on first establishment of College of Chemistry, 5674: Numbers of students working in, and of those who have received their chemical education; its laboratories before and after its connexion with Government, 5681, 5682. Schedule of original researches executed in, since 1845, 5682. List of students whose subsequent career is known, 5683.

Only one laboratory at College of Chemistry for students of all grades, 5693.

The proposed laboratories at South Kensington, if devoted entirely to chemistry, would be about equal to those at Bonn, Berlin, and Leipzig, and a little superior to that at Zurich, 5704.

Amount of fees paid for, at College of Chemistry; expense of materials not included in fees; fees are too high, higher than in private institutions and on the continent, 5716–5719.

The existing laboratories in Oxford Street barely one tenth of the space proposed to be assigned to them at South Kensington, which would not be too large for all London; necessity of providing accommodation for three classes of students, 5732, 5733.

If additional assistants be granted, they should be able to give subsidiary courses of lectures, 5749–5751.  
No full information of intended details of, at South Kensington; recommendation that they be applied as a school for training science teachers, not only for chemistry but for physical sciences generally, 5756–5759.

Germany and France better supplied with laboratories than England; they are supported by the State; good laboratories in sufficient number could not be provided in this country without assistance from Government, 5873–5875.

Necessity of a separate building for, in studies of original research, 5893.

*Laboratory (Chemical) Expenses.*

The grant of 2*l.* per pupil to each teacher on account of, now in operation; minute quoted stating conditions on which the grant is made; grant of 50 per cent. also on the price of certain apparatus, 771–774.  
Are not included in the fees paid at College of Chemistry 5716–5718.

*Laboratory (Chemical) Instruction.*

Teaching of chemistry of little value without laboratory instruction; questions should be so framed as to necessitate it, 776, 777.

Small number of teachers who came for, to laboratory in Oxford Street last year; good effect of the instruction; proposed increase of the numbers this year, 778–785.

Very limited at College of Chemistry for want of space; number of teachers of science who come for, their acquirements generally good; impossibility of teaching many branches for want of room, 5688–5693.

Given, to classes for teachers, so far as it went of great avail, 5754, 5755.

*Lectures.*

The lectures at College of Chemistry are framed for students of Chemistry; unsuitable for medical or art students, 5730.

Students from Inland Revenue attend lectures at College of Chemistry, 5777, 5831.

See also *Evening Lectures*.

*Magenta.*

Invented and manufactured by students of College of Chemistry, 5683.

*Marburg University.* See *Prussian Universities*.



FRANKLAND, PROF.—cont.

*Medlock, Mr.*

One of the inventors of magenta, a student of College of Chemistry, 5683.

*Metropolitan College of Science (proposed).*

The most desirable purpose to which the projected building at South Kensington could be devoted would be as a training college for teachers, 5756–5759.

Scheme of, as prepared by Capt. Donnelly, requires modification; cost of training 120 students, independently of salaries, should be estimated; a class of ordinary students desirable, for teachers to work with, 5760–5767.

Chemical investigations for other institutions, such as Rivers Pollution Commission, &c., might be carried on at, with saving of expense, but more space would then be required, 5768–5772.

Toxological inquiries with relation to judicial decisions should not be undertaken at, 5773, 5774.

A centralization of chemical instruction at, could only be partially carried out with advantage, some district schools being necessary; a training for the higher class of students might be available, 5778–5780.

Its governing body should consist of a dean and council, similar to School of Mines, which works well, 5850–5852.

In buildings proposed there should be spaces set apart for those who would enter as original investigators in chemistry, on certain conditions, 5890–5893.

See also *Laboratories (Chemical)*.

*Metropolitan Railway.*

Takes away much of the objection of South Kensington as a locality for the College of Chemistry, 5752, 5753.

*Mining Record Office.*

Might with advantage be transferred to present premises of College of Chemistry, if the latter be removed to South Kensington, 5724.

*Neild, Alderman.*

Successful endeavours of, in establishing a chemical professorship and laboratory in Owens College, 825.

*Nicholson, Mr.*

Inventor and manufacturer of magenta, a student of College of Chemistry, 5683.

*Nova Scotia University.*

Professors of chemistry in, trained in College of Chemistry, 5683.

*Organic Chemistry.*

Examination papers on, in May 1870, pp. 107–109.

*Original Researches in Chemistry.*

Non-recognition of, in England, a reason for backward state of chemical scientific research, 5867.

List of, executed in laboratories of College of Chemistry since 1845, 5682.

Necessity of proof of, in Prussian universities, 5868.

Examinations for medical degree not of a nature to elicit original research, 5872.

Experiments made in working out, in Owens College; Dalton scholarships there for, 5882.

A country neglecting, must suffer in comparison, 5883–5885.

Recognition of original research in chemistry by universities, most wanted at present, 5894.

Necessity for separate building for, 5893.

Competitive examinations, as now carried on, inimical to, 5896.

*Owens College, Manchester.*

An economical institution; a comparative calculation with the College of Chemistry shows that the latter is carried on with great economy, 5830.

Present incomplete state of, 5875.

Dalton scholarships in, given for original research in chemistry, 5882.

*Per-centages.*

Of success and failure in examinations in chemistry in 1868 and 1869, 766; in 1870, 767.

Per-centage of papers of original research in chemistry to investigators in Germany, Great Britain, &c., 5866.

*Perkin, Mr.*

Importance of his researches in the laboratories of College of Chemistry, as discoverer of aniline colours, 5682, 5683.

*Playfair, Dr. Lyon.*

Letter of, explaining circumstances of transfer of College of Chemistry to Government, 5667.

*Pollution of Rivers Commission.*

The expense of laboratory of, might be saved by having the investigations made at proposed Training College of Science, 5768.

26060.

FRANKLAND, PROF.—cont.

*Private Institutions for Teaching Chemistry.*

Offer more advantages to students than College of Chemistry, in prizes and scholarships; fees lower; would not be affected by extension of proposed college, 5714, 5715, 5720.

See also *Competition*.

*Privy Council Office.*

Expense of chemical analyses made for, might be saved by the proposed Training College of Science, 5772.

*Prizes.*

None, except Whitworth scholarships, given to students who have not passed the elementary paper before taking up the advanced; the condition is proper, but restricts number of candidates, 767, 768.

Offered by College of Chemistry very meagre compared with other institutions, 5714.

*Prussian Universities.*

Degrees in science not granted in, till after stringent examination, 5792.

In all Prussian universities candidates for degree of doctor of philosophy must submit a paper on original chemical research. More candidates rejected at Marburg for failure in original research than in after examination, 5868.

See also *Germany*.

*Queen's College, Galway.*

Professors of chemistry in, trained in College of Chemistry, 5683.

*Queenwood College.*

Successful teaching of chemistry in, to boys under 13, 5859.

*Research (Chemical).* See *Original Researches in Chemistry*.

*Rouen.* See *Chemistry*.

*Royal Agricultural College, Cirencester.*

Professors of chemistry in, trained in College of Chemistry, 5683.

*Royal College of Chemistry.*

Examinations in, in 1868, 1869, and 1870; reports thereon quoted, 766, 767.

Small number of teachers who came last year to, for instruction; proposed increase in numbers next year, 778–785, 767. Of those who received instruction many had fair theoretical, but little experimental knowledge of teaching, 792.

Limited accommodation at, 784, 5683, 5688–5693, 5689. No further outlay in Oxford Street desirable; accommodation for, in Jermyn Street impossible, 5697–5700, 5721, 5836.

History of the College from its foundation to the present time; with number of students, original researches conducted there, and list of students whose subsequent career is known, 5667–5683. One third of those who have passed through the college have gained some distinction, 5684.

All its students are nominally connected with School of Mines, but many attend only the chemical course, 5685–5687.

Arrangements at, for instruction of science teachers; laboratory can only contain one third of applicants; laboratory instruction in; mental capacity and attainments of students; impossibility of teaching many important branches of for want of space; admission repeatedly refused for want of accommodation, 5688–5693.

South Kensington for the proposed chemical laboratories is a locality more desirable than convenient; the buildings there, if devoted to chemistry, would be about equal to those at Bonn, Berlin, and Leipzig, and a little superior to that at Zurich, 5701–5704.

Evening lectures, in connexion with, are held at Jermyn Street for science teachers and for working men; the former do, the latter do not, pay their expenses; no examinations connected therewith, 5705–5713.

Any extension given to, would not exercise much effect upon voluntary and self-supporting institutions; the fees at, are higher than in private institutions, and should be lowered; any impulse given to study of chemistry would be of general benefit, 5714–5720.

Assistance given to, by the State, of very partial character, 5720.

Term yet to run of lease 14 years; rent paid for premises; portion let off; Mining Record Office might be transferred to present premises if the college be removed to South Kensington, 5696, 5721–5725.



FRANKLAND, PROF.—*Royal College of Chemistry*—cont.

At the time of its establishment classes of chemistry were held at King's and University Colleges; notwithstanding, the want of such an institution was much felt; large subscriptions for, at first, 5726, 5727.

Fulfills the specific purpose for which instituted more than any other institution; students are required to devote themselves almost exclusively to chemistry, 5728–5730.

Does not at present possess one tenth of the space for laboratories proposed to be assigned at South Kensington, which would not be too large for all London, three sets of laboratories being required, 5732, 5733.

If additional assistants be accorded to, they should be capable of giving subsidiary courses of lectures, being assistant professors more than laboratory assistants, and remunerated accordingly, 5749–5751.

The Metropolitan Railway takes away much objection to South Kensington as a locality for, 5752, 5753.

Staff officers of engineers have worked at, e.g. Col. Reynolds and Capt. Hozier, 5781.

Before the opening of, not 20 students received instruction in practical chemistry in all England, except medical students, and for them the practical instruction was limited, 5782–5787.

Institutions cited with which the College of Chemistry might possibly come into competition, 5814, 5815.

Many students who come to, are beginners, 5817.

Stands in the relation of laboratory to School of Mines; time lost in passing from College to Jermyn Street, 5818, 5819.

Majority of students who have passed through, have devoted themselves to technical pursuits; brewers keep a constant stream of students, 5822, 5834.

Gross amount of fees received yearly in, 5823.

Few analyses executed in, for private account; payments for these go to the professor, 5824–5827.

The rent, fittings, &c., and one assistant supplied by Government; the library by professor and students; the expenses, when compared with Owens College at Manchester, show that it is managed with economy, 5828–5830.

Many students come to, who are destined for employment in the Inland Revenue and Indian telegraph service, 5831.

Reasons for converting it into a Government institution; no room in Jermyn Street; not self-supporting; few students in, who are not entered as pupils of School of Mines, having preference as such, 5836–5841.

The proposed nine months' course of instruction in, must be gratuitous; no security can be had that the students would not enter into trade afterwards, 5842–5846.

Its most important function should be that of a training college for teachers, 5847.

In case of its removal to South Kensington the connexion of the Geological Survey and School of Mines might cease, 5848.

Government contemplated for the new training schools much the same as that of School of Mines, which works well, 5850–5853.

*Royal College of Science, Dublin.*

Professors of chemistry in, trained in College of Chemistry, 5863.

*Royal School of Mines.*

Amalgamation of Royal College of Chemistry with, 5677–5679.

Evening lectures held at, for science teachers and working men; the first do, the latter do not, pay their expenses; are generally well attended; no examinations attached to them, 5705–5713.

All the professors of, complain of want of space, 5734. Part of new building at South Kensington might be devoted to, 5735.

The College of Chemistry is its chemical department; much time wasted in passing from one locality to the other, 5818, 5819.

Facilities in Jermyn Street for the special training of particular classes of students, which should continue there, 5820.

Students in College of Chemistry are entered as pupils in, and have preference as such, 5839–5841.

Proposed disconnexion of Geological Survey from, if College of Chemistry be removed to South Kensington, 5848.

*Royal School of Naval Architecture.*

Portion of new building at South Kensington intended for; if it could be accommodated elsewhere, two, if not three, departments might exist side by side there, 5735, 5736.

## FRANKLAND, PROF.—cont.

*Science Schools.*

Programme for 1871 addressed to, as to six weeks' instruction during June and July, cannot be carried out, the School of Mines and College of Chemistry being then both in session, 5737.

There are several, in which a considerable amount of advanced chemical knowledge can be acquired, 829–831.

See also *Chemistry. Royal College of Chemistry.*

*Science and Art Department.*

The system of examination now carried on by, develops self-taught ability, 795–801.

*Science Teachers.*

Many science teachers in chemistry are beginning to fit up small laboratories, 763.

Science teachers in chemistry get no payment for candidates in advanced examination who have not passed elementary one, 767–769.

Science teachers in chemistry entitled to a grant of 2l. per pupil for laboratory expenses, 771–773.

Small number who came to Oxford Street last year for laboratory instruction; good effect of their attendance; proposed increase of numbers this year, 778–785.

Arrangements at College of Chemistry for instruction of science teachers; their number; lectures; limited accommodation; mental capacity and attainments of students; repeated refusal of admission from want of space, 5688–5693.

Of those who came up to College of Chemistry last year, many possessed considerable theoretical knowledge, but were deficient in practice; not fair specimens of teachers throughout the country, the best men would not come; were selected as having some knowledge of chemistry, 792, 5739–5748. Two instances of first-rate men who came to see the methods of the college, 5743.

Classes for science teachers in chemistry, and the laboratory instruction given, of great assistance, 5754, 5755.

An institution such as that projected at South Kensington necessary to furnish a sufficient number of science teachers for the country, 5756–5759.

Intended teachers of elementary day schools should undergo an additional nine months' teaching in chemistry to enable them to teach science classes efficiently; the teaching should be gratuitous, 5792–5799, 5845. The supervision of an organizing master would be required; existing teachers of chemical classes are not on the whole satisfactory 5800–5812.

Their low remuneration; some have improved their positions, 5800–5802.

The special training of science teachers more the subject for Government interference than elementary training; many who come to College of Chemistry are beginners, 5816, 5817.

Science teachers should be taught their first two years in a central school, the third year in a special class, as in the School of Mines, 5820. Men like Faraday are of immense value, and the cost of their education might well be defrayed by the State, 5821.

Majority of students in College of Chemistry have devoted themselves to technical pursuits, 5822, 5834.

No absolute security can be had against science teachers entering into trade; admittance might be refused without agreement to serve a certain number of years, 5842–5846.

The chief function of the College of Chemistry should be as a training college for teachers, 5847.

No one competent to teach elementary chemistry without a training such as the nine months' training contemplated, 5854, 5855.

From the method pursued in this country, science teachers are incompetent to teach science, 5865.

*Science Teaching.*

Science teaching in chemistry improves from year to year, 763, 766, 767.

Should stimulate applications of science to the arts, and enable scientific talent to develop itself, 5821.

Backward state of, in Great Britain as compared to Germany and France; reasons for this, 5866, 5867.

See also *Examinations.*

*Science Training.*

Want of a system of; complaint thereupon; no definite conclusion arrived at by Department on the subject, 786, 787.

*South Kensington.*

Chemical laboratories at, in course of construction, intended for training teachers; separate laboratories for different grades; their erection delayed, 788–791.



FRANKLAND, PROF.—*South Kensington*—cont.

Would as a locality for chemical laboratories be more desirable than convenient, not being sufficiently central, 5703.

The laboratories there, if devoted entirely to chemistry, would be about equal to those at Bonn, Berlin, and Leipzig, and something superior to that at Zurich, 5704.

The whole of the new building at, is not intended to be devoted to chemical purposes; the portion intended for College of Chemistry is not too large for all London, 5733–5704.

The Metropolitan Railway takes away much objection to, as a locality for the College of Chemistry, 5752, 5753.

## Steiner, Mr.

Of Accrington, advantage of his knowledge of chemistry as applied to dyeing, 823, 824.

Students in Chemistry. See *Royal College of Chemistry*.

## Sydney University.

Professors of chemistry in, trained in Royal College of Chemistry, 5683.

Technical Chemistry. See *Chemistry*.Training College for Teachers. See *Metropolitan College of Science (proposed)*.

## Water Supply Commission.

The expense of analyses made for, might be saved by a Training College of Science as proposed, 5772.

## Whitworth Scholarships.

Can be taken by candidates who have not undergone the elementary examination, 768.

## Working Men.

Evening classes for, at School of Mines, Jermyn Street, generally well attended; do not pay their expenses; no examination attached to them, 5705–5713.

## WOOLLEY, REV. JOSEPH, LL.D. (Index of his Evidence.)

Admiralty. See *Students of Royal School of Naval Architecture*.

## Age of Science Students.

Of Admiralty students at School of Naval Architecture, 882, 998.

Of students commencing at dockyard schools, 14 years, 1015.

## Application du Génie Maritime.

School of, in France, corresponding to our School of Naval Architecture; pupils of, employed in summer in dockyards; their ignorance of nautical matters at first entering, 954–956.

## Astronomer Royal.

Lectures by, on magnetism as applied to ships' compasses, to School of Naval Architecture, 1006.

Board of Trade Examination. See *Examinations*.

## Chemistry.

Difficulty of procuring instruction in, for students of School of Naval Architecture; lectures to be delivered by Dr. Frankland, 943, 944, 980–982, 1007.

## Chief Constructor of Navy.

An instance of advantage of applying theoretical knowledge to naval architecture, 926, 927.

## Children.

Boys attending Hull school chiefly sons of mariners, 862.

Of those employed in dockyards not necessarily selected as apprentices, &c., in dockyard schools, 1013, 1014.

Well-instructed and clever boys enter dockyard schools as engineer students, 1016.

## Diaries (Students').

Required to be written by Admiralty students in dockyards, 907, 953, 990.

## Dockyard Schools.

There are schools at all the dockyards, 885.

Entirely for apprentices and engineer students, 1013, 1014.

Well-instructed and clever boys enter, as engineer students, 1016.

Partly day and partly evening schools, 1017.

A little elementary knowledge in several subjects taught in; 1018, 1019.

## Elementary Instruction in Science.

A little, in several subjects, given in dockyard schools, 1018, 1019.

See *Science Instruction*.

## WOOLLEY, REV. J.—cont.

Electricity. See *Physics*.

## Examinations.

One at end of every session in School of Naval Architecture, 1002.

Quarterly, specially designed for those at sea; little resorted to; candidates for, chiefly from Leith; theoretical only and of no practical advantage; the scheme has not answered, 865–875.

Mariners and others actually in practice care for little but passing the Board of Trade examination, which is one of practice only, 871, 875.

## Foreign Students.

At present in School of Naval Architecture, 993.

## Frankland, Dr.

Arrangement with, for lectures on chemistry to students of School of Naval Architecture, 943, 980–982.

## Greenwich Hospital School.

The best teachers of navigation are old pupil teachers of, 848, 858, 860.

## Hull.

Navigation school at; number and good character of papers from; Mr. Scaping, its master, one of the best teachers of navigation in the country; class of boys attending the school, 845, 849–852, 857–864.

## King's College.

The class of applied science at, chiefly for civil engineers, 967.

## Laboratories.

In course of erection at South Kensington, for College of Chemistry, partly for use of School of Naval Architecture; the building in abeyance, 946–948.

Laboratory of School of Naval Architecture not at present extensive; its intended enlargement, 944–997.

## Lectures.

Given at School of Naval Architecture; their nature and cost, 943, 944, 979–982, 1007.

## Leith.

Navigation school at; quarterly examinations principally from; good teacher at, 845, 870.

Magnetism. See *Physics*.Marine Engineers. See *Naval Architects and Marine Engineers*.

## Mathematics.

A knowledge of, requisite for admission into School of Naval Architecture, 890, 987.

## Medical Schools.

Cost of four years' instruction for medical students, 973. If taught by persons whose whole income was derived from students' fees, would not be remunerative, 974–976.

Medical Students. See *Medical Schools*.

## National Schools.

Failure of boys sent from, for examination in navigation and nautical astronomy, 853–855.

Nautical Astronomy. See *Navigation and Nautical Astronomy*.

## Naval Architects and Marine Engineers.

Distinction between, rapidly diminishing as regards dockyards, but not as regards students; half the Admiralty students will become engineers in the navy, 923.

In private practice, do not generally appreciate the Royal School of Naval Architecture; they are educated in a commercial point of view, 928, 929.

Increase of knowledge of, abroad, 933, 934.

## Naval Architecture.

The want of professional theoretical knowledge of, led to establishment of School of Naval Architecture, 877. Not much demand for theoretical knowledge of, 901.

Studied by those in private practice only in a commercial point of view; great increase of study of, abroad, 923–934.

Instance of advantage of applying theoretical knowledge to, 926, 927.

Much of mathematics taught not special to, 937.

The school of should be divided into two branches, the higher to be devoted to naval architecture simply, 937–939, 941.

## Navigation and Nautical Astronomy.

Examinations in, by witness; diminution in numbers examined, but improvement in character of work; reasons for such diminution, 839–847, 856.



WOOLLEY, REV. J.—*Navigation, &c.*—cont.

Failure of boys in, sent for examination from national schools, 853–855.

The best teachers of, are old pupil teachers of Greenwich Hospital School, 848, 858, 860.

Majority of papers sent for examination were in navigation, few in nautical astronomy, 856.

*Navigation Schools.*

Diminution in number of, except Hull and Leith; good character of these two, 845, 849–852, 870.

Favourable position of Portsmouth school, and of the pupils issuing from it, 919–922.

*Portsmouth.*

School of mathematics and naval construction formerly at; success of pupils trained at; reasons for its being discontinued, 911–918.

Good position of present navigation school at, and the pupils issuing from it, 919–922.

Failure of Portsmouth school in the practical part of instruction, 988, 990.

*Physics.*

Great difficulty in procuring good instruction in, especially magnetism and electricity, for students of School of Naval Architecture; lectures on magnetism as applied to ships' compasses by Astronomer Royal, 943, 1005, 1006.

*Polytechnic Schools (French).* See *Royal School of Naval Architecture.**Practical Instruction.*

Of Admiralty students in the dockyards, 905–910, 953, 983–985.

Abroad has greatly increased lately, 933, 934.

Desirability of distinction between schools of theory and of application,—between instruction in pure science and its practice, 936–939, 241, 958–960.

Few opportunities of acquiring practical skill in French polytechnic schools, 954–956.

The school at Portsmouth broke down in the practical part of the instruction, 988, 990.

*Rankine, Professor, of Glasgow.*

Reference to his class for teaching naval architecture, 925.

*Royal School of Naval Architecture.*

Its origin; term of course of instruction in; limited number of students; no limit of age at; two classes of students, those sent by Admiralty, and private, 876–884.

Does as much work as expected, 900.

Its staff and cost, 902, 903; 500*l.* a year paid for lectures at, 904.

Not generally appreciated by naval architects and marine engineers in private practice, 928.

Much now taught at, common to other professions, 936.

Course of instruction in, should be divided into two branches, theoretical and applied, which would save expense, 936–939, 941, 999, 1000.

Attempt at, to give combined instruction similar to that in the polytechnic schools and schools of application of France, 940, 941.

Has no classes similar to those of School of Mines; great want of some such school in contact with it; its great difficulty (just overcome) of obtaining good elementary instruction in chemistry, 942–945.

Advantage of having College of Chemistry under same roof, 945–948.

Instruction now given in, such as would be required in a training school for science teachers, 949–952.

The general and scientific instruction for intended students in, should have a special direction, 977, 978.

Open to anyone on payment of the fees; foreign students in, 992, 993.

Its present laboratory not extensive, 994.

Ages of students at, 998.

*Sandhurst College.*

General and special school at, 940.

*Scaping, Mr.*

Master of Hull Navigation School, one of the best teachers of navigation, an old pupil teacher of Greenwich Hospital School, 857–860.

*School of Mathematics and Naval Construction.*

Formerly existing at Portsmouth; its high character, and good position of pupils proceeding from it; reasons for its discontinuance, 911–918.

## WOOLLEY, REV. J.—cont.

*Science Examinations.*

Examinations for fellowships and associateships, and in navigation and nautical astronomy, in Royal School of Naval Architecture, held by witness; good results thereof; diminution in numbers, but improvement in character of work, 836–847.

*Science Instruction.*

In existing colleges determined by the destination of the students, 978.

*Science Teachers.*

In a school for training teachers, the instruction would require to be very similar to that now given in School of Naval Architecture, 949–952.

*Science Teaching.*

Students' first two years should be devoted to pure science, then practical application, 958–960.

The best can only be had in a special school under Government; or in other institutions, determined by a programme and tested by examinations, 961–968. The latter course not desirable for students in School of Naval Architecture, 977, 978.

Cost of four years' instruction would be about the same, whether in a Government institution or in independent schools; medical science could not be taught as it is if the teacher's whole income were derived from fees of students, 971–976.

*South Kensington.*

Building of laboratories at, in abeyance, 946–948.

*Students' Diaries.* See *Diaries.**Students of Royal School of Naval Architecture.*

Term of course of instruction; no limit as to age; are selected from the dockyard schools; their number; of two classes, Admiralty and private; the first maintained at public expense; their satisfactory subsequent career, 879–888, 893–899.

The cost for board and lodging of, not included in stated cost of school, 903, 904.

The Admiralty students are required to work in Royal Dockyards, and to furnish monthly reports, 905–909, 953, 990. Private students may attend on same conditions, 910.

Apprentices or engineer students bound to Admiralty receive wages in addition to maintenance, 983–985.

Ages of students at School of Naval Architecture, 998.

Number of, now in the school, 991. Foreign, in the school, 993.

Few private students in School of Naval Architecture do well, not having sufficient mathematical knowledge, 1001, 1003. Future career of private students, 1004.

Advisability of more general instruction for first two years of course, 1008–1010.

Admiralty students reside in private lodgings; their general good behaviour, 1011, 1012.

Knowledge of chemistry and physics required in, before coming to Kensington, 1012.

Engineer students in dockyard schools not necessarily selected from children of persons employed in dockyards, 1013, 1014.

Well-instructed and clever boys enter as engineer students, 1016.

*Theoretical Scientific Instruction.*

The want of, among naval architects, led to establishment of School of Naval Architecture, 877.

Not much demand for, in country generally, 901.

Limited means of acquiring, in naval architecture and marine engineering, 925–928.

*Training College for Science Teachers.*

Instruction in, would require to be such as is now given in School of Naval Architecture, 949–952.

*Woolwich Academy.*

Attempting to do the same work as Royal School of Naval Architecture 940.

## MERRIFIELD, C. W., Esq., F.R.S. (Index of his Evidence.)

*Age of Science Students.*

They leave the School of Naval Architecture at about 22 years of age, 1136.

*Admiralty.*

Admiralty schools, their limited duration, 1026, 1027.

Admiralty send 30 students in four years to School of Naval Architecture; superiority of these to private students in same school, 1029, 1033, 1034, 1055, 1164. Subsequent employment of these students, 1163.

Diaries required to be kept by Admiralty students while in dockyards; of great utility, 1051–1053.



MERRIFIELD, C. W.—cont.

*Articled Pupils.*

Are received at nearly all the great engineering establishments; it is the common mode of education of naval architects and marine engineers in private practice; have no connexion with School of Naval Architecture, 1072–1074, 1089, 1090.

Many are instructed in science in a London college, 1099–1101.

*Catechetical Instruction.*

Used with students in School of Naval Architecture, 1148.

Should be applied only to subjects requiring much thought, 1149.

*Chemistry.*

Unsatisfactory teaching of, in School of Naval Architecture; to be supplemented by lectures; defect in laboratory course, which cannot be remedied till the school and College of Chemistry be combined, 1151, 1152.

*College of Chemistry.* See *Royal School of Mines and College of Chemistry.*

*Competition.*

Any extension generally of course of instruction at School of Naval Architecture would create more competition with private establishments, which at present is not alarming, 1069–1071.

*Cost.*

Of whole course of instruction for one student in School of Naval Architecture, 1041, 1123, 1124. Statement of the instruction included in the cost, 1125.

*Diaries (Students').*

Required to be kept by Admiralty students while in dockyards; of great utility, 1051–1053.

*Differential Calculus.* See *Todhunter's Differential Calculus.*

*Dockyards.*

Employment of students of School of Naval Architecture in, during summer only supplementary to their theoretical instruction; regulations for their full employment while there, 1049–1053.

*École du Génie Maritime, Paris.*

The primary education in, presupposes a thorough knowledge of mathematics, 1064.

A very small school, 1067.

*Écoles de Maistrance.*

In French dockyards, are schools for foremen, 1087, 1088.

*Education.*

What is called in this country a fair general education, means very little, so far as accurate information is concerned, 1114, 1115.

A new special school necessary for students intended for School of Naval Architecture, 1127.

*Examinations.*

Held at School of Naval Architecture, 1038–1040, 1078, 1079, 1080, 1081.

*Fees.*

Paid by private students at School of Naval Architecture; foreign students admitted on same terms, 1061, 1062. Appropriation of such fees, 1130.

*Foreign Students.* See *Fees. Lectures. Students of School of Naval Architecture.*

*Frankland, Dr.*

An assistant examiner in School of Naval Architecture, 1080.

*Inspector-General.* See *School of Naval Architecture.*

*Laboratory (Chemical)*

Attached to School of Naval Architecture, 1048. Unsatisfactory nature of the laboratory course, 1151, 1152.

*Lectures.*

Delivered at School of Naval Architecture; their utility barely commensurate with their cost, 1044, 1045.

System of *répétiteurs*, as used in France, in case of lectures, necessary here for foreign students, 1144–1146. And would be necessary for English students if lectures were extensively used, 1147, 1148.

On chemistry to be delivered in School of Naval Architecture; insufficiency of laboratory course, and inconvenience of separation of school from College of Chemistry, 1151, 1152.

*Marine Engineers.* See *Naval Architects and Marine Engineers.*

MERRIFIELD, C. W.—cont.

*Mathematics.*

A thorough knowledge of, presupposed at *École du Génie Maritime*, Paris, 1864.

There should be one central school for teaching, the pupils afterwards to resort to special schools of application, 1065.

Little speciality in, as taught at School of Naval Architecture, 1066. Might be rendered more useful to more extended class of students, 1068.

A separate school of, simply to feed the School of Naval Architecture, not desirable; if there were many such schools a preliminary education in mathematics and general physics would be economical, 1105. Such instruction could not be practically got in the present state of education, 1106, 1107.

Bad result to students in School of Mines and College of Chemistry through not being well grounded in, 1108.

Application to Government by School of Mines for chair of mathematics, 1109.

Desirability of preliminary instruction to students in mathematics and general physics, 1110, 1111. A special school necessary for such purpose, 1112, 1113.

Examination in, at entrance, would have the effect of excluding students rather than ensuring the knowledge, 1140.

There being no instruction in, in School of Mines, and no instruction in chemistry in School of Naval Architecture, an interchange of arrangement might be possible, 1141–1143.

Lectures on, only used to supplement text books, 1150.

*Naval Architects and Marine Engineers.*

The large proportion of, throughout the country, have been brought up in the royal dockyards, 1090–1092.

Receive little theoretical instruction in private ship-building yards, save what they get by private arrangement with the chief draughtsman, 1093–1098.

Pupils of, are frequently instructed in science in some one college, chiefly University or King's College, 1099–1101.

*Naval Museum.*

No educational duties connected with office of superintendent of; models in, occasionally used in School of Naval Architecture, 1153, 1154.

*Patent Museum.*

Models in, only occasionally used in School of Naval Architecture, 1155.

*Percy, Dr.*

An assistant examiner in School of Naval Architecture, 1080.

*Physics.* See *Mathematics.*

*Portsmouth Dockyard School.* See *Woolley, Dr.*

*Practical Instruction.*

Advisability of separation of theoretical and practical instruction, 1065, 1066.

A course of applied mechanics and applied mathematics taught in School of Naval Architecture, 1076.

See also *Royal School of Naval Architecture. Theoretical Instruction.*

*Rankine, Professor, of Glasgow.*

An assistant examiner in School of Naval Architecture, 1080.

*Reed, Mr.*

Constructor of the Navy, an assistant examiner in School of Naval Architecture, 1080.

*Répétiteurs.* See *Lectures.*

*Reports, &c.*

References to, on School of Naval Architecture in Minutes of Science and Art Department, supplied by witness, page 66.

*Royal School of Mines and College of Chemistry.*

Ill result to students of, through not being well grounded in mathematics; application to Government for a chair of mathematics; a preliminary course of general study needful to students; a special school would be necessary for such purpose, 1108–1113.

*Royal School of Naval Architecture.*

Established about six years ago; no similar schools in the country at the time; reasons for its establishment, 1023–1028.

Students sent to, from the Admiralty, 30 in four years; small number of private students in, 1029–1032, 1164.



**MERRIFIELD, C. W.—*Royal School, &c.*—cont.**

Superiority of Admiralty to private students, 1033, 1034. Scholarships and free studentships granted at, 1035–1037.

Examinations held at, 1038–1040.

Course of instruction in, might be rendered more useful to a more extended class of students, 1068. In that case more competition with other educational establishments would be created, which as yet has not been serious, 1069–1071.

Inspector-General the official examiner of, 1039. Names of his assistant examiners, with their subjects, 1078–1081.

Instruction in, embraces all desirable branches of knowledge, 1042, 1043.

Chemical laboratory attached to, 1048.

Subjects taught at: pure mathematics, and its special application to calculations of ships; applied mechanics and applied mathematics, 1075–1077.

At present held in temporary buildings, which are poor and unsatisfactory, 1082–1086.

A separate school of mathematics not expedient, simply to feed the school; if there were several such schools, a separate school of mathematics and physics would be economical, 1105.

Is intended to give the theoretical course required to supplement the practical course given in dockyards to students and apprentices. Little specialty in course of instruction to marine engineers, but no attempt made to get mechanical engineers into the school, 1118–1122.

Duties of vice-principal of, 1156, 1157.

Career open to persons who pass through, 1158–1160.

Only one set of students has left after a four years' course, 1161, 1162.

See also *Examinations*.

**Russell, Mr. Scott.**

Instrumental in establishing School of Naval Architecture, 1028. Assistant examiner in the school, 1080.

**Scholarships and Free Studentships.**

Granted by School of Naval Architecture, 1035–1037.

**Students' Diaries.** See *Diaries*.**Students in School of Naval Architecture.**

Number of, sent by Admiralty, and of private students, 1029–1032, 1164. Of foreign students, 1060.

Superiority of Admiralty students to private students, 1033, 1034, 1054, 1055.

Cost of whole course for each student, 1041, 1123, 1124.

Employed in dockyards during the summer, 1049.

Private students in the school come from all classes, 1056.

Fees paid by private and foreign students, 1060–1062.

Appropriation of those fees, 1130.

As a rule go into Government service and give satisfaction; their general age on leaving the school, 1134–1136, 1165. Only morally bound to Government, 1137.

One entered Lloyd's without permission, and was censured, 1135, 1163.

Their superiority due partly to selection and training before entering the school, 1166.

**Studentships.** See *Scholarships*.**Theoretical Instruction.**

The want of, in shipbuilding, led to establishment of School of Naval Architecture, 1028.

Supplemented, for Admiralty students, by practical work in the dockyards, 1049–1053.

Advisability of having a division of theoretical from practical instruction, 1065, 1066.

Little theoretical instruction imparted in private establishments; often a matter of private arrangement with chief draughtsman, 1093–1098.

**Todhunter's Differential Calculus.**

A text book in School of Naval Architecture, 1148.

**Woolley, Dr.**

Limited duration of Portsmouth Dockyard School under, 1027.

Instrumental in establishing School of Naval Architecture, 1028. Examination in the school held by, 1038.

**WILLIAMSON, DR. ALEXANDER, F.R.S. (Index of his Evidence).****Agricultural Colleges.**

Failure of, such as at Cirencester, as technical schools, 1360, 1361.

**Apparatus for Science Purposes.**

Professors should be assisted with, 1229.

**WILLIAMSON, DR. A.—cont.****Assaying.**

Taught correctly in technical schools, 1297.

**Chemistry.**

Should be first taught pure and experimentally; its practical application to follow in manufactories, &c., 1172.

Method of witness in conducting his classes, 1190–1192. Inadvisability of whole course of chemical technology being acquired by students of applied science, 1220–1221.

Government aid to, might be regulated by a proposed council of education; 1245–1251.

*Cirencester.* See *Agricultural Colleges*.

**Cole, Mr.**

Consulted as to Government appointments, 1209, 1210.

**College Tests.**

Better than examination tests alone, 1186, 1187; but should not take their place, 1188, 1189.

See also *Examinations*.

**Competition.**

Free competition among all schools the main element of success; no duty of Government to compete with existing establishments; Government institutions inconsistent with true competition, therefore injurious, 1175–1177, 1196, 1214.

All institutions should be on the same footing, and public utility the sole object, 1253–1259. No unfair competition would then result, 1306–1313.

**Council of Education.**

On the supposition there were such, its duties, constitution, and duration, 1232–1238, 1244.

Members of, might be judges how far State aid should be given for scientific researches or grants to chairs, 1245–1251, 1272, 1273.

**Council of Scientific Advice.**

To aid Government; how to be constituted, 1271, 1272, 1388–1390.

**Cramming.**

Tendency of examination tests to produce cramming, 1187*a*.

**Elementary Schools.**

Desirability of teaching elementary science in primary schools, 1199–1203.

**Examinations.**

Undue value attached to examination tests; would do more good if better applied; not always the best man succeeds in; partiality may be shown in, 1186–1189, 1320.

In any system of examination there will be failures; publicity necessary, 1267.

How to remedy some of the evils of, 1317, 1318, 1374.

**Fees.**

Science teachers should be neither solely dependent on nor altogether independent of fees, 1229.

**France.**

Failure of French system in professing to teach industrial applications of science in schools, 1173.

Government aid to science in, 1182.

The French system of endowments for support of science teachers undesirable, 1229.

**Freiberg School of Mines.**

Practical and theoretical teaching at, 1341–1343, 1345.

Its distinctive excellence mainly practical, 1377, 1378.

**Germany.**

Fault and failure of German system in professing to teach industrial applications of science in schools, 1173.

Government aid to science in, 1182, 1314–1316.

State aid to science in Germany does not interfere with independence of governing bodies of universities, 1194, 1314–1316.

System of "Privat-docenten," or junior professors, in; more direct contact of professors and students in, than in England, 1268–1270.

**Government.**

Royal Society properly consulted by, on scientific subjects. Other persons, Mr. Cole, for instance, also applied to, 1209, 1210, 1212.

See also *Council of Education*. *Council of Scientific Advice*.

**Government Grant Fund.**

Satisfactory working of; might be well extended, 1284–1291, 1391.



WILLIAMSON, DR. A.—cont.

*Government Grants in aid of Science.*

Importance of neutrality in application of Government aid to science, which should not compete with existing institutions, 1175-1177, 1193.  
 State aid should be given gradually, and according to improved knowledge, 1178-1180.  
 Might found scholarships in schools attended by poor, and provide apparatus, &c. in higher branches; limitation of usefulness in English colleges for want of State aid, 1181, 1182.  
 Advantage of official sanction to teaching of science, 1183.  
 Government encouragement should not take shape of political appointments, but should increase means of usefulness in science, 1184, 1185. Might be applied to institutions not at present recognized, 1189.  
 State aid in Germany does not interfere with independence of governing bodies of universities, 1194.  
 State aid in shape of Government educational institutions inconsistent with true competition, 1196, 1197, 1214.  
 Better results if applied to private institutions, 1198.  
 Manner in which and conditions on which Government aid should be applied, 1229-1232.  
 Explanation of statement that Government should not aid any one theory; general principles to be considered, 1239-1241.  
 Might be regulated by a proposed council of education, 1245-1251.  
 Special aid is granted to Government schools, rendering competition with colleges, &c. unequal, 1252-1259.  
 With State aid, a system of inspection may fairly be imposed, 1260-1266.  
 Professors and efficient schools should receive State aid, 1283, 1323-1329.  
 On principle, State should not interfere in science teaching, 1305.  
 State aid should be applied as impartially to private bodies as to public, 1306-1313.  
 German system of State aid, 1314-1316.  
 Incomes of science teachers not sufficient from private sources; State aid should be given for salary or endowment, not as payment by results, 1330-1337.  
 Should be applied as incentives to original research and skill in teaching, 1364-1373.  
 Advantage of State aid on the continent; might be applied in England to incomes or allowances in old age for professors, 1380-1383.  
 General principles as to application of State aid to teachers of science, 1384, 1385, 1398.  
 Even were private endowments sufficient, importance of Government aid should be acknowledged, 1402.

*Inspection.*

Inspection might be imposed on institutions receiving State aid, 1260-1266.  
 Suggestions as to application of a system of, 1386, 1387.

*Laboratory (Chemical).*

Report as to building of, at South Kensington, without scientific advice, 1211, 1213.  
 Should be kept in reserve till proposed council of education determine upon it, 1242-1244.

*Laboratories (Metallurgical).*

Study in, best made in the works themselves; deficiency of present modes of analysis in many, 1222-1224.  
 At present only imitations of practice, not practice itself, 1346-1352.

*London University.*

System of examiners at, good, 1318.

*Medical Schools.*

Not technical schools, in witness's acceptance of the term, 1293-1296.

*Mining.*

Advantage in learning mining of preparatory training in general science, 1198. Actual practice in a mine essential, 1215, 1216.

*Minister of Education.*

One anticipated, 1390.

*National Schools.*

National education unsatisfactory which does not include elementary science, 1199-1203.

*Normal Schools.*

So-called normal schools are a fallacy, 1276.

*Original Research.*

State aid might be applied as incentive to, 1364-1373, 1398.  
 Originators are often teachers, in shape of lecturers, 1399.

*Owens College.*

Salaries to professors in, 1401.

WILLIAMSON, DR. A.—cont.

*Practical Instruction.*

The most effectual; best given by itself; theory may accompany it, 1279, 1280, 1343.  
 As given in metallurgical laboratories, only an imitation of practice, 1346-1351.

*Privat-docenten.*

System of, in Germany, 1268.

*Public Schools.*

The introduction of science teaching in, desirable, even as an adjunct to literature, 1204-1208.

*Regius Professorships.*

Need not be abolished, but their endowment gives an advantage over others unendowed, 1301-1305.

*Répétiteurs.*

System of, in France, 1268.

*"Responsible Reports."*

Meaning of, as applied to University College system of filling up vacant chairs; desirability of applying the system to Government appointments, 1193.

*Royal School of Mines.*

Different in practice from what it professes to be; as a school of mines does not justify its existence; is really a school of science, and as such does good work, 1197, 1198.

*Royal Society.*

Sometimes consulted by Government on scientific subjects, 1209, 1212.  
 Government grant fund administered by, with good effect, 1284-1289, 1391.

*Science Instruction.*

Inexpediency of teaching elementary science with a view to specific applications, 1172. Applied to industrial pursuits, cannot be well taught in schools and colleges, as instanced in the French and German schools, 1173.  
 Importance of an earnest example in; general want of sympathy with, in England; advantage of, even in a pecuniary point of view, 1174.  
 Suggestions as to the duty of Government with regard to, 1175-1177.  
 Necessity of Government aid in teaching higher branches; great aid given to, in Germany and France; limitation of usefulness in England for want of such aid, 1182-1185.  
 Examination tests of, not always correct; really good teaching not produced by examinations, 1186-1188.  
 Manner in which Government aid might be applied to, in institutions not at present recognized, 1189.  
 Necessity and advantage of tutors under professors in conducting large classes, 1190-1192.  
 Should be included in any system of national education, 1199-1203.  
 Should be added to study of literature in public schools, 1204-1208.  
 Room for special teaching between scientific instruction and its practical application, 1217-1219.  
 A student of applied chemistry need not go through whole course of chemical technology, 1220-1221.  
 Errors of continental practice in teaching applications at first, instead of theory, 1225.  
 A student not so liable to learn bad practice in works as in school, 1226. Theory should be implanted before practical application, 1227, 1228.  
 Assistance of tutors in teaching science more general on the continent than in England; "Répétiteurs" in France, "Privat-docenten" in Germany, 1268-1270.  
 State aid should be applied as incentive to skill in, 1364-1373. And in shape of suggestions as to results of experience, 1376.  
 Professors should not be subject to necessity of extraneous work for income, 1379, 1381-1383.

*Science Schools.*

Futility of attempting to teach the industrial applications of science in schools and colleges, 1173.  
 Limitation of usefulness of colleges in England for want of Government aid in providing apparatus, &c., 1182.  
 The School of Mines is really a school of science, and as such does much good, 1197, 1198.  
 Error of some continental schools in teaching application of science before theory, 1225.  
 Objection to establishment by Government of technical schools in opposition to science schools, 1338.

*Science Students.*

Not so valuable in manufactories as expected, from want of proper early training, 1173.  
 Former custom of continental nations to send students to this country to learn science, 1227, 1228.



## WILLIAMSON, DR. A.—cont.

*Science Teachers.*

Unfavourable position of, in England, for doing their duty to students, 1174.

Necessity and utility of intended science teachers acting as tutors in large science classes, 1190–1192.

Should not be dependent on, nor independent of, fees; a small salary should be given; position should offer a reasonable career, 1229. Apparatus and assistants for, should be supplied by the State, 1229, 1230.

How they are to be developed; existing resources should be more utilized; theory and practice should be combined, 1276–1280.

The training of, should be superadded to schools generally, 1322.

Limited sources of income for; necessity of State aid 1330–1334.

General principles as to application of Government aid to, 1384, 1385, 1398.

Originators in research are often lecturers, 1399.

Men training for, at University College, 1392–1394.

No room in higher colleges for training, for elementary schools, 1395.

How trained, 1396, 1397.

*Scientific Advice.*

Method in which scientific advice is sought by Government, 1209, 1210, 1212.

A large laboratory to be built by Government, without scientific advice, 1211, 1212.

Generally given to Government through Royal Commissions; should be by a council, publicly, and after discussion, 1195, 1232–1238, 1271–1273, 1388–1390.

*Society of Arts.*

Report of Committee on Technical Education in connexion with, referred to, as to study of pure science being the groundwork of technical education, 1274–1276.

*Technical Education, Committee on.* See *Society of Arts.*

*Technical Schools.*

Objections to, 1292–1300.

Assaying correctly taught in, 1297.

Objection to establishment of, by Government, in opposition to science or trade schools, 1338, 1376.

Objections to, generally, 1344–1352. Failure of agricultural colleges as technical schools, 1360, 1361.

*Theoretical Instruction.*

Best given by itself, preparatory to application in practice, 1343.

*University College.*

Students brought to, to be taught chemistry applicable to specified purpose, 1172.

Instance in its laboratory of the uncertain value of examination tests, 1187a.

Classes in, under professor and tutors; advantage of the arrangement to both tutors and class, 1192.

Its procedure, as to filling up vacant chairs in the college, 1193.

No adequate means in, of remunerating tutors for instructing how to teach, 1282.

Science teachers in training at, 1392–1394.

Endowments in, 1400.

*Woolwich.*

Studies at, are chiefly pure science; but science applied to war is taught to some extent, 1339, 1340, 1353–1359.

## JENKIN, PROFESSOR FLEEMING, F.R.S. (Index of his Evidence.)

*Age of Science Students.*

Boys of 13 or 14 may be made good draughtsmen, and can learn chemistry, geometry, and elementary physics.

Instances at the École Chaptal, 1664, 1729.

Sufficient preliminary scientific education can be obtained before 18 years, 1740, 1741.

*Apprenticeship of Engineers.*

Practice prevails in England; not on the continent, 1580.

Objections to colleges in lieu of apprenticeship, 1584, 1601, 1604.

Applied engineering taught to apprentices during apprenticeship, 1687–1692.

*Artizans.*

Need of mechanical drawing felt by artizans; classes originated by them, 1615.

Watt Institution for, in Edinburgh, produces admirable results, 1630, 1633–1644.

Teaching of managers more important than workmen; producing power of artizans little increased by scientific teaching, 1701–1707, 1784.

JENKIN, PROF.—*Artizans.*—cont.

More continental artizans can draw than English, 1704–1706.

Only artizans who come voluntarily can be taught science, 1707.

Better education for, desirable, which would increase chances of invention, 1784–1787.

*Art Schools.*

Mechanical drawing should be taught in, as a separate branch, 1620–1629.

*Birmingham.*

Institution like Owens College wanted in, 1667–1669.

*Bradford.*

Similar institution to Owens College wanted in, 1775.

*Chairs of Science.*

Government should endow chairs of engineering, &c., conditionally, on chairs being successful; more are required, 1604, 1646, 1669, 1670, 1772, 1773, 1779.

In Edinburgh University, are endowed by the State; considerable salaries attached to some, 1645–1647, 1650, 1651.

*Children.*

Capacity for learning science of boys of 13 or 14 years, 1664, 1729.

Some show aptitude for literary, others for scientific training, 1736.

*Colleges of Science.*

Objection to establishment of colleges for engineers, in lieu of apprenticeship, 1584, 1601, 1604, 1756–1760, 1767.

Special colleges for engineers on the continent; do not turn out such good men as English system, 1580, 1594.

Objection to State engineering college for Indian officers, and “Government science,” 1767, 1768.

*Competitive Examinations.*

Objections to, 1585, 1659, 1662, 1747, 1750.

*Continent.*

Linear drawing more taught than freehand on the continent, 1615. Continental workmen can draw better than English, 1704–1706.

Competition of continental with English engineers, 1693–1695.

Allusions to continental polytechnic schools, 1584, 1673–1677, 1755.

*Council of Scientific Advice.*

Desirable to aid Government by; how council might be formed; difficulties respecting responsible reports, 1658–1661, 1761–1764.

*Directory (Science and Art).*

Inadequacy of, with respect to mechanical drawing, 1616. Regulations as to building grants; approval of this, 1641.

*Drawing (Mechanical).*

England behind in; instruction wanted, which should not be given by a teacher of freehand, 1615–1629.

More accuracy of observation inculcated by mechanical than by freehand drawing, 1619.

Should be taught as a separate branch in art schools, 1620–1629.

Better on the continent than in England, 1615, 1704–1706.

Advantage of, to operatives in textile manufactures, 1787.

*Drawing Teachers.*

Same teacher should not instruct in both freehand and mechanical drawing, 1629.

*École des Arts et Métiers.*

Approximation to the workshop at, 1759.

*Edinburgh.*

Absurd teaching of mechanical drawing in, 1615, 1618.

Scientific instruction in, promoted by University, Watt Institution for working men, School of Arts, and Museum of Science and Art, 1630–1656.

Not room for another university in, 1667.

*Edinburgh University.*

Spends 3,000*l.* a year on science teaching, 1630.

Professorships in, endowed by the State; considerable salaries attached to some; university rather poorly endowed, 1645, 1647, 1650, 1651.

Many students in; entrance examination desirable, 1647, 1648, 1654, 1655, 1714–1721. Number, &c. attending witness's courses, 1710–1712.

Institutions similar to, wanted in Birmingham, &c., 1667–1669.



## JENKIN, PROF.—cont.

*Education.*

Of engineers, English and foreign, and medical men, 1580–1582, 1739–1741, 1748–1750, 1756.  
 Education of engineers bad; objection to training colleges in lieu of apprenticeship, 1584, 1601, 1604.  
 Of telegraph officers very deficient, 1585–1588, 1604–1612.  
 Difficulty of giving grants for education of people who can and do pay, 1727, 1728.

*Elementary Education.*

Approval of system of payment on results for, 1615.  
 Capacity of boys for science at 13 or 14 years, 1664, 1729.  
 Second-grade schools bad in Scotland as regards science, 1656–1658.

*Endowments.*

Approval of proposal of School Commission to apply certain endowments to science schools, 1734.  
 See *Chairs of Science*.

*Engineering.*

Tendency to extravagant expenditure on, in France, 1598–1600.  
 Government could aid, by endowment of chairs; also by payment on results (but not on present principle), 1604, 1613, 1615.  
 See *Colleges of Science*.

*Engineers.*

Different system of educating, abroad; combination of English and foreign system desirable, 1580–1582.  
 English pupils preferable for work, 1581, 1594, 1595, 1597.  
 Profession of, is becoming more complex, 1583.  
 Objection to colleges for, in lieu of apprenticeship, 1584–1601, 1604.  
 Good preliminary theoretical education not required of, 1589, 1602.  
 System of pupilage very remunerative to, 1601.  
 Government must provide higher instruction for, 1603, 1604.  
 Objection of witness to his pupils being examined by any but himself, 1613.  
 Entrance examination desirable for engineering students; also for medical men, &c., 1647, 1648, 1654, 1655, 1714–1721, 1737–1739.  
 Indian examination for, objected to; approval of Carlsruhe system, 1662.  
 Should not be selected ready-made, but should be sent to the first engineers for practical instruction, 1663, 1664, 1671, 1672.  
 Should come for instruction, after having been in contact with real work, 1681.  
 Applied engineering not to be taught to apprentices till towards close of apprenticeship, 1687–1692.  
 Effort must be made by our engineers to keep ahead of those of the continent, 1693–1695.  
 Witness's students in Edinburgh University are all training for, 1711–1713. They might get preliminary training anywhere, 1722–1724.  
 Similar training to that of engineers required by medical students, 1739–1741.  
 Preliminary scientific education may be attained by before 18 years, 1741. Should ultimately pass through technical courses, 1742–1744.

*England.*

English engineers preferable to foreign, 1581, 1594, 1595, 1597.  
 Mechanical drawing on the continent far better than in England, 1615–1629, 1704–1706.  
 Competition of engineers on the continent with those of England, 1693–1695.

*Foreigners.*

English engineers preferable to, 1581, 1594, 1595, 1597.

*France.*

Tendency to extravagant engineering in, 1598–1600.  
 Workmen in, are well instructed in linear drawing, 1615, 1707.  
 Objection to "Government science" in, 1767.

*Germany.*

Better engineers are turned out in Britain than in German polytechnic schools, 1584.  
 Workmen in, better instructed in linear drawing than artisans here, 1615, 1707.

*Government.*

Engineer officers, &c. under, deficient in science education; suggestions for remedying this, 1585–1588, 1604–1612.  
 To enforce preliminary examination in Edinburgh University, Government assistance necessary, 1654, 1655.

26060.

JENKIN, PROF.—*Government*.—cont.

Desirability of aiding, by an elected council of scientific advice, 1658–1661.

Indian appointments of; disapproval of examinations for, 1662.

Might establish science schools, but they should afterwards be severed from the State, 1768.

*Government Grants in aid of Science.*

Necessity for, in respect to endowment of chairs of engineering, 1603, 1604. Might be given as payment by results (but not results of examination), 1613.

Same system of grant not applicable to both elementary and higher education, 1615.

Government should furnish rooms, apparatus, &c., for teaching mechanical drawing, 1620.

Professorships in Edinburgh University are endowed by the State; number should be increased, 1645–1647, 1676.

Objection to State college and "Government science," 1767–1773.

Additional science institutions are required, for which State aid will be essential, 1666–1669.

Difficulty of giving grants for education of classes who can and do pay, 1727, 1728.

Should be applied in teaching managers, rather than workmen, 1699–1707.

*India.*

Government appointments in; disapproval of the engineering examinations for, 1662.

Practically educated engineers essential for, 1663, 1664.

Objection to Government engineering college for, 1765–1768.

*Lectures.*

On telegraphy, should be instituted in several parts of the kingdom, 1691–1693.

*Literature.*

Science will afford as good culture as classics, 1734.

Should be blended, in teaching, with science, 1736.

*Machinery.*

Knowledge of, necessary for teacher of mechanical drawing, 1629.

*Managers.*

More important to educate managers than workmen, 1701–1707, 1784.

*Manchester.*

Advantage of its position with regard to scientific instruction, 1778.

*Mathematicians.*

Contrasted with physicists in respect to original research, 1666, 1667.

*Mechanical Drawing.* See *Drawing (Mechanical)*.*Mechanics' Institutes.*

Fault in, a want of long courses of lectures, 1640.

*Medical Schools.*

Not a place where a man is taught to be able to learn his business, 1755, 1756.

*Medical Students.*

Preliminary scientific examination desirable for, and similar training to engineers, 1739–1741.

Might obtain sufficient preliminary scientific education before 18 years, 1741.

No objection to a pass examination for, 1748–1750.

*Museum of Science and Art, Edinburgh.*

Largely attended; lectures given in; no examination, 1630–1632.

*Newcastle.*

Institution like Owens College wanted in, 1667–1669.

*Original Research.*

Will be promoted by improving profession of scientific man; might be remunerated by proposed council of advice, 1665–1667.

*Owens College.*

Institutions like, required in Birmingham, &c., 1667–1669, 1775.

Special chairs of mining, &c., should be superadded to, 1779–1782.

Would be aided by secondary schools, giving instruction in science, 1782.

*Payment on Results.*

Government might assist in education of engineers by, but not on mere results of examination, 1613.

System of, more appropriate to elementary than to higher education, 1615.

*Physicists.*

Contrasted with mathematicians, in respect to original research, 1666, 1667.



JENKIN, PROF.—cont.

*Polytechnic Schools.*

Good class of, in Germany, &c.; but better men are turned out under English system, 1584, 1755.

Reaction in, against teaching mechanical arts, 1673–1676.

*Practical Instruction.*

English engineers preferable to continental in respect to practical work, 1581, 1594, 1597.

Students who learn are those who have been previously in contact with work, 1596.

Witness's assistants contrasted with Chatham students, respecting theory and practice, 1604–1612.

Theoretical instruction (as in continental polytechnic schools) should precede practical, 1676–1682, 1687.

*Professorships.* See *Chairs of Science.*

*Railways.*

Competition with German engineers respecting railways in eastern Europe, 1695.

*Responsible Reports.* See *Council of Scientific Advice.*

*Schools' Inquiry Commission.*

Allusion to, respecting grammar schools, 1726.

Approval of proposal of, to apply certain endowments to science schools, 1734.

*Science.*

Without theoretical knowledge of science eminence has been attained by engineers, but will not be in the future, 1583.

Bad teaching of, in Scotch elementary schools, 1656–1658.

Additional institutions for, required, in Birmingham, Newcastle, &c.; State aid will be essential, 1666–1669. Should be learned as theory, practice, and application of theory to practice, 1673–1679, 1682, 1776, 1777.

Rapid increase of science instruction might result from good teachers, 1730, 1731.

Will afford as good culture as classics, 1734.

Should be blended, in teaching, with literature, 1735.

Aptitude of some children for; of others for literature, 1736.

Objection to "Government science," 1767.

*Science and Art Department.*

System of, does a great deal, and should be extended, 1615.

Inefficient teaching under, of mechanical drawing, 1615–1629.

Increase of candidates under, not a reason why teaching should be unsound, 1708, 1709, 1732, 1733.

See *Directory (Science and Art).*

*Science Examinations.*

For telegraph officers, 1585, 1586.

Should be strict, but not stricter for larger number of candidates, 1708, 1709, 1732, 1733.

Preliminary science examination desirable for students of engineering, and for all scientific professions, 1647, 1648, 1654, 1655, 1714–1721, 1737–1739.

Disapproval of the examination for Indian appointments; approval of Carlsruhe system, 1662.

Pass examinations (not competitive) desirable, 1747–1751.

*Science Schools.*

Like Owens College and Edinburgh University, wanted in Birmingham, Newcastle, &c., 1667–1669, 1775.

Want of, about the country; difficult for Government to aid them, 1725–1728.

Approval of proposal of School Commission to apply certain endowments to, 1734.

Separate science schools desirable, 1734, 1735.

Government might establish, and leave them to other management, 1768, 1772.

Graded science schools would increase success of such institutions as Owens College, 1782.

*Science Students.*

Preliminary science examination desirable for students of all scientific professions, 1647, 1648, 1654, 1655, 1714–1721, 1737–1739.

See *Engineers.* See *Science and Art Department.*

*Science Teachers.*

Should be well paid, 1652.

With competent teachers, there might be a rapid increase in scientific instruction, 1731.

See *Chairs of Science.*

*Scotland.*

Bad teaching of science in elementary schools of, 1656–1658.

Room in, for fresh chairs, but not a fifth university, 1772. See *Edinburgh.*

JENKIN, PROF.—cont.

*Secondary Schools.*

Scotch second-grade schools bad, as respects teaching of science, 1658.

Would promote success of institutions like Owens College, &c., 1782.

*Technical Instruction.*

Technical classes wanted for students of telegraphy, &c., all over the country, 1585, 1603.

Should follow pure science, 1666–1682.

Desirable in the universities, 1743–1746.

No objection to technical education—properly understood, 1752–1754.

Given to engineers' apprentices during apprenticeship, 1687–1692.

Technical schools not desirable, but technical courses in universities, 1773.

*Telegraphy.*

Necessity for action with respect to; present officers inefficient; proposed course of instruction in, 1585–1588, 1604–1612, 1696, 1697.

Lectures on, ought to be instituted in several parts of the kingdom, 1591–1593.

Inefficiency of officers sent out for, 1696, 1697.

Students of, at Chatham; their deficiency in practical knowledge, 1604–1612.

*Theoretical Instruction.*

Continental engineering students superior to English in theoretical knowledge, 1581, 1589, 1590, 1602.

Engineers have become eminent without theoretical knowledge; difficult in future, 1583.

Theory not the foundation of practice, 1604–1612.

Theoretical instruction should precede practical, 1676–1682, 1687.

No amount of practice can qualify without theoretical instruction, 1696.

*Universities.*

Technical instruction desirable in, 1743–1746.

*University of Edinburgh.* See *Edinburgh University.*

*Watt Institution, Edinburgh.*

For artisans; produces good results with small means, 1630, 1633–1644.

*Workshops.*

Practice in workshop should follow study of theory, 1678, 1776, 1777, 1783.

Tendency in, to subdivide labour, a ground for special courses of instruction, 1684–1686.

Approximation to, at École des Arts et Métiers, 1759.

RICHARDSON, WILLIAM, Esq. (Index of his Evidence.)

*Aix-la-Chapelle.*

Admirable polytechnic school at, created by subscriptions and Government aid, 1836–1841.

*Art School in Oldham.*

Subjects taught therein, 1801, 1802. Art school the best place to learn technical drawing, 1896.

*Algebra.* See *Mathematics.*

*Artizans.*

Advantages of the schools in Oldham to artizans, 1806, 1808, 1809. Expedients for making the schools more attractive, 1814.

Character of artizans sent to India, 1830, 1831.

A rough class; difficulty of getting them to attend science classes, 1878.

Some are teachers of science classes in the Oldham district, 1904.

Some from Oldham frequent Owens College, 1934.

*Artizans (Foreign).*

Employment of, previous to establishment of the Oldham schools, 1826, 1842.

*Augsburg.*

Mill managers' club at Augsburg; improvements publicly discussed there, 1848.

*Chemistry.*

Endeavours to establish a chemistry class at Oldham, 1802, 1910.

*Children.*

Those intended for manual labour should be put to it early, 1809, 1851, 1878, 1881, 1889.

Are exhausted by night examinations, 1814.

Artizan boys cannot study much geometry without encouragement, 1815.

School subscriptions paid for, 1833, 1870.

Long hours of employment of, formerly, 1882.



**RICHARDSON, W., Esq.—Children—cont.**  
 If kept at school too long, have a distaste for manual labour, 1889.  
 Ten per cent. of children would repay trouble spent on teaching, 1916–1919.  
 Promotion of, should depend on their assiduity in science schools, 1818–1820. Which would be to interest of employers, 1821, 1822.

**Classification of Trades.**  
 Advantage of, 1852.

**Cramming.**  
 Former prevalence of, under Department; overcome by a teacher of good personal character, 1903.

**Drawing.**  
 Taught at Art school in Oldham; numbers attending the classes, 1802, 1803, 1920.  
 Advantage to artizans in being able to draw, 1828, 1890–1893.  
 Instances of, in letters from Mr. Nasmyth of Patricroft, 1894.  
 Best learnt in Art school, 1896.  
 Should be enforced as a study, 1921–1923.

**Elementary Education.**  
 Opinion of masters of Oldham schools as to serious want of sound elementary education by artizans, 1806, 1809.  
 Imperfect state of, in Oldham, 1887, 1888.

**Elementary Schools.**  
 In Oldham, 1795, 1799, 1800, 1807.  
 Rudiments of mathematics and Euclid should be taught in, 1806, 1807.  
 Sound elementary instruction should be imparted in, 1897.

**Elementary Science.**  
 Opinions of masters of schools in Oldham as to progress and advantage of, and as to the best method of introducing it into the schools, 1806–1808, 1810, 1819.  
 Advantage of instruction in, shown by superiority of foreign artizans, 1842–1848.  
 Encouragement should be afforded to students in, 1899–1901.  
 Advantage of a knowledge of, to a workman, 1919.

**Evening Classes.**  
 Boys devoted to manual labour have strength to attend evening classes, 1881–1886.  
 Science teacher of, in Oldham, is occupied all day in preparing subjects, 1906–1911.

**Euclid.** See *Mathematics*.

**Examinations.**  
 Complaint of severity of; should be accompanied by prizes, 1814–1816.  
 Payments to teachers on results of, 1902.

**Fees.**  
 Paid in Oldham science schools, 1860.

**Foreign Artizans.** See *Artizans (Foreign)*.

**Foreign Machinery.** See *Machinery*.

**Free Schools.**  
 Free schools in Oldham instituted by Mr. Platt, 1825.  
 A system of, advocated, 1871, 1874, 1930, 1931.

**India.**  
 Character of artizans sent to, 1830, 1831.

**Lyceum.**  
 At Oldham, schools in connexion with; how managed; subjects taught at; 1795–1799, 1802, 1912–1914.  
 See also *Science Schools*.

**Machinery.**  
 Machine drawing taught at Oldham science school, 1802.  
 Advantage to artizans in being able to draw machinery, 1809, 1827, 1828, 1892–1894.  
 Improving character of foreign machinery, 1845–1848.  
 The study of, by artizans, should not be pushed too far; desirability of classification of trades, 1852.

**Manual Labour.**  
 Persons intended for, should begin early, 1809, 1851, 1874, 1889, 1896.  
 No hindrance to attendance at evening classes, 1881–1886.

**Mathematics.**  
 The rudiments of Euclid, algebra, and trigonometry should be taught in elementary schools; mathematics and Euclid taught in Oldham science school, 1806, 1807. Some private pupils in, 1908.

**RICHARDSON, W., Esq.—cont.**  
**Metallurgical Teaching.**  
 Few artizans likely to take up, 1878.  
 Desirability of early knowledge of, 1880.

**Mill Managers' Club at Augsburg.**  
 Witness's visit to, 1848.

**Nasmyth, Mr., of Patricroft.**  
 Instance of advantage in possessing a power of mechanical drawing, 1894.

**Oldham.**  
 Educational institutions in, 1795, 1887, 1912–1914.  
 Supervision of the schools, 1817, 1833.  
 Endeavours to establish a chemistry class at, 1802, 1910.  
 Some artizans at, go to Owens College, Manchester, 1934.

**Owens College, Manchester.**  
 Additional schools like, should be established, 1932, 1933.  
 Some artizans from Oldham attend, 1904.

**Payments by Results.**  
 In Oldham schools, 1902.

**Per-centage.**  
 Of boys in Oldham schools who repay the trouble bestowed upon them, 1916–1919.

**Platt, Mr.**  
 Salary of master of science school first paid by, 1804.  
 Science schools in Oldham built and presented to the town by, 1825.  
 Manufacture of iron for his own works undertaken by, 1857–1879.

**Polytechnic School.** See *Aix-la-Chapelle*.

**Practical Instruction.**  
 Desirability of early practical science teaching, 1824, 1851.  
 Advantage of practice over theory, 1852, 1853.

**Prizes.**  
 Needed as encouragement in elementary science schools, 1809, 1810, 1815, 1816, 1899. Should proceed from local sources, 1900, 1901.

**Rankine, Professor.**  
 Science teacher in Oldham schools recommended by, 1804–1903.

**Reports.**  
 Of masters of Oldham schools, as to progress of students in, and advantages and deficiencies of the schools, 1806, 1808, 1810, 1814.

**Salaries.**  
 Of science teachers in Oldham, 1804, 1813, 1862, 1864–1866, 1928, 1929.

**School Fees.**  
 Paid by masters for those unable to pay for themselves; no demoralising effect therefrom, 1833, 1870, 1930, 1931.

**Schools in Oldham.**  
 Number and character of, 1795.  
 See also *Art School*. *Free Schools*. *Lyceum*. *Science Schools*.

**Science Schools.**  
 Subjects taught in, in Oldham, 1802.  
 Reports of masters of, as to class of students, increased efficiency of schools, &c., 1805–1810, 1814.  
 Boys in first stages in, want encouragement, 1815.  
 Better supervision of, needed; of interest to both employers and students, 1817–1822, 1833, 1901.  
 Advantage of, to masters and men, 1824.  
 Admirable polytechnic school at Aix-la-Chapelle, 1836.  
 Fees paid in Oldham, 1860.  
 Salaries in, see *Salaries*.  
 Subscriptions paid for boys unable to pay, 1833, 1870.  
 Minor science schools in neighbourhood of Oldham, small, but useful, 1904, 1905.  
 Have been established in Oldham about seven years, 1823, 1927.  
 Of higher grade, should be established in all large towns, 1932, 1933.

**Science Teachers.**  
 Science teacher at Oldham recommended by Prof. Rankine, 1804, 1903.  
 Suggestions as to mode of making them more efficient, 1809, 1810.  
 In Oldham, have no other occupation, 1811, 1812. Their salaries, see *Salaries*.  
 Their suggestions as to making schools more attractive to artizans, 1814.



RICHARDSON, W.—*Science Teachers*—cont.

- Opinions of, as to desirability of prizes for boys, 1816.
- The time of, in large establishments, fully occupied, 1867, 1868, 1906–1909.
- Payment by results to, 1902.
- Artizans employed as, in mechanics' institutions, &c., 1904.
- In manufacturing towns other than Oldham, 1924–1926.

*Science Teaching.*

- Value of, to superintendents of works, 1827.
- Character of artisans improved by, 1832.
- Advantages of instruction in, 1850, 1876, 1877.
- In Oldham, occupies all the time of the teacher, 1908–1911.

*Theoretical Instruction.*

- Useful chiefly as stepping-stone to practice; not desirable to push it too far, 1851–1853.

*Trigonometry.* See *Mathematics*.

## APPLEGARTH, MR. ROBERT. (Index of his Evidence.)

*Accidents.*

- More numerous among miners in England than on the continent; would be diminished if miners were skilled workmen, 1969, 1970.

*Adult Schools.* See *Evening Schools*.*Age of Science Students.*

- Children can be taught elementary science from eight years of age, 1943, 1944.
- See *Apprentices. Children*.

*Apprentices.*

- Age at which apprenticeship should commence, 1975–1979, 1988–1993.
- Cannot work at some trades; they are not taken, 1982–1984.
- Trade education of, neglected the early part of their time, 1987.
- Part of their time should be occupied in scientific instruction, 2044.

*Arbitration.*

- A system of, between employers and workmen, inaugurated, 1997, 1998.

*Artizans.*

- Attempts of men to study elements of science they should have learnt when boys, 1953, 1954, 1958.
- Desire of, to acquire technical science; correspondence with Professor Jenkin on the subject, 1955. Proceedings taken, and schools established in consequence, 1956–1960.
- In England, workmen have no opportunities of becoming skilled, as compared with foreign workmen, and have no special qualities to counterbalance want of scientific knowledge, 1970, 1971.
- Diversity of intelligence amongst; the least instructed most prone to resist improvements, 1999–2004.
- Not assisted by employers in establishing schools to the extent expected, 2005, 2302, 2042–2045.
- Better treated abroad than in England, 2011, 2012.

*Artizans (Foreign).*

- Power of, to make drawings of machinery, 1969.
- Industrial school of Belgian miners, 1970.
- Advancing competition of, with English workmen, 1970, 1971. Better treatment of, 2011.
- Scientific knowledge of, among Swiss watchmakers and in ribbon factories at Basle, 2010.

*Basle.* See *Artizans (Foreign)*.*Bradford.*

- Science school established at, by artisans, 1958.

*Busbridge, Mr.*

- Science teacher to schools established in London by artisans, 1962–1967.

*Carpenters and Joiners' Amalgamated Society.*

- Success of classes instituted by, 1957.
- Loans made by, to promote technical education, 1958.

*Children.*

- Elementary science necessary to be taught to, 1941–1946.
- Should not be taken from school and put to manual labour under 14 years of age, 1975–1977, 1989–1991.

*Competition.*

- Of foreign artisans with English workmen; advantages possessed by the former, 1970, 1973. Not to be feared if English workmen be instructed in technical science, 2000–2004.

## APPLEGARTH, MR. R.—cont.

*Compulsory Education.*

- A system of, should be inaugurated, 1946–1948, 1994.
- Science teaching cannot be carried on without, 1994–1996.
- No feeling against, in Switzerland, 2014–2018.

*Cramming.*

- Many science teachers addicted to, 1963, 1964.

*Creuzot.*

- Reference to Mr. Samuelson's account of Messrs. Schneider's schools at, 1969.

*Drawing.*

- As taught in classes instituted by Amalgamated Society of Carpenters and Joiners, 1957.
- Practice of, by artisans, 1958.
- Ability of continental workmen in, 1969.

*Dyeing.*

- Superiority of continental workmen in, 1793, 1974.

*Education Department.*

- Should be consolidated with Science and Art Department, 1952, 2039.

*Elementary Education.* See *Primary Schools*.*Elementary Science.*

- Age at which children can receive, 1943.
- Should be taught in primary schools, 1946.
- Difficulty of adult artisans attempting to acquire, 1953.
- Advantage taken of classes for, in mechanics' institutions, &c., 2041.

*Employers.*

- Should be compelled to establish trade schools, 1946–1948.
- Have not taken the interest in science schools for artisans that was desired, 2032, 2042–2045.

*Evening Science Schools.*

- In London, are all for adults, 1957.

*Fees.*

- Paid in trade schools established by artisans, 2021–2023.

*Germany.* See *Technical Education*.*Government Grants in aid of Science.*

- Duty of Science and Art Department to provide for science teaching, 2028–2030, 2034.

*Hull.*

- Difficulty of procuring a science teacher for schools at, 2019, 2030, 2046.

*Iron Trade.*

- No necessity for boys to be put early to, 1980–1985.

*Jenkin, Professor.*

- Correspondence with, on the question of technical education being undertaken by trades' unions, 1955.

*Joiners.* See *Carpenters and Joiners*.*Lecturers.*

- The lecturing power of the Science and Art Department should be distributed over the country, with special application to special localities, 2034–2036.

*Loans for Science Instruction.* See *Carpenters and Joiners*.*Manchester.*

- Science school in, started by artisans, 1956.

*Manual Labour.*

- Much early training for, may be given in school, 1985.
- No advantage in beginning too early, 1976–1979, 1987–1991.

*Miners.*

- More accidents among, in England than elsewhere; owing to want of scientific education, 1969, 1970.
- Want of success in teaching science to miners owing to want of early compulsory education, 1994–1996.

*Payments by Results.*

- To teachers of trade schools, 2021–2023.

*Pimlico.*

- Artizans school in; difficulty in obtaining premises for, 1956, 2005.

*Practical Schools in Germany.*

- Notice of, in French Report on Technical Education, 1945.

*Primary Schools.*

- Elementary science should be taught in, and attendance at schools made compulsory, 1940–1944, 1946–1948, 1994.
- No objection to compulsory attendance, at Zurich, 2015.

*"Real Schulen."* See *Practical Schools*.*Ribbon Weavers.*

- Scientific knowledge of, at Basle, 2010.

*Samuelson, Mr.*

- Works at Creuzot described in letter of, 1969.



APPLEGARTH, MR. R.—cont.

*School Fees.* See *Fees*.

*Science Education.*

At present not sufficient; should be given in elementary schools, 1940–1944. Should be compulsory, 1946.  
Steps taken towards, by artisans, 1956, 1957.  
Superiority of, among continental artisans to that of English workmen, 1969–1973, 2010.  
Suggestions for improvement of, among working classes, 2025, 2026, 2030.  
Little interest taken by employers in scientific education of workmen, 2032, 2042–2045.

*Science Classes.*

Of Science and Art Department, are doing good; some improvements might be introduced, 1950–1953, 2025, 2026.

General progress of artisans in, 1953, 1954, 1958.

Instituted by trades' unions, 1956–1961. Science teacher in, 1962–1966.

Difficulties of artisans in obtaining rooms for, 2005.

Fault of Department in frequently altering rules for, 2039.

At Creuzot, Mr. Samuelson's report of, 1869.

*Science and Art Department.*

Science classes under, are doing good, and capable of doing more, 1950–1952.

Suggestions for improvement of its action among artisans; its duty to supply aid for the purpose, 2025–2030, 2034, 2038.

Antagonism of, with Education Department; they should be consolidated, 1952, 2039.

Fault of, in frequent alteration of its rules, 2039.

*Science Teachers.*

Difficulty in finding, for trade schools, 2019. Their remuneration, 2022.

Difficulties of, under regulations of Science and Art Department, 2039.

*Science Teaching or Training.* See *Technical Education*.

*Schneider's Schools.* See *Creuzot*.

*Sheffield Independent.*

Article from, quoted, as to success of trades' unions schools, 1957.

*Switzerland.*

Excellence of technical education in, 2010.

No objection to compulsory education in, 2015.

*Technical Education.*

Extract from French Report on, as to the system in Germany, 1945.

Suggestions as to provision of, in England, 1946–1949.

Correspondence on subject of, with Professor Jenkin, 1955. Proceedings taken in consequence, 1956.

Extract from "Sheffield Independent" as to success of trades' unions' schools, 1957.

Lord Lichfield's committee for promoting, 1958.

State of, on the continent, superior to that in England, 1969–1974.

Might be commenced in school, 1985, 1986.

Duty of employer to teach scientifically as well as practically, 1992.

Duty of Science and Art Department to supply, 2030.

*Trade Schools.*

Employers should be compelled to establish, 1946–1949.

Success of, established after correspondence with Professor Jenkin on the subject, 1955–1958.

Instruction in, in Switzerland, 2010.

Difficulty in finding teachers for, 2019.

*Watchmaking.*

Scientific knowledge of, among Swiss workmen, 2010.

BATE, C. SPENCE, Esq., F.R.S. (Index of his Evidence.)

*Accommodation for Science Purposes.*

Want of, in Plymouth Science School, 2064.

*Charles Science School, Plymouth.*

An independent school; cause of its establishment; subjects taught in, and per-centages; its master, 2064, 2066, 2068, 2071, 2088.

*Contributions for Science Purposes.*

Difficulty in procuring, in Plymouth, 2101.

*Cramming.*

One who crams to pass an examination or obtain payment by results, not fit to be a science teacher, 2085, 2089, 2112, 2113.

*Devonport.*

Programme of science classes at, 2135.

BATE, C. S., Esq.—cont.

*Dockyard School, Plymouth.*

Master teaches too many things, 2079.

*Dockyard Students.*

Restriction on payments by results with respect to, works badly, 2064, 2075.

*Examinations.*

In navigation schools, not sufficiently frequent, 2054, 2060. Are becoming more severe; might be made more so, 2070, 2114–2116. Should be practical, as well as theoretical, 2112.

*Fees.*

Paid in Plymouth Science School, 2097–2099.

*Government Grants in aid of Science.*

Difficulty in meeting, with local subscriptions, in Plymouth, 2101, 2133.

Not sufficient to secure good masters, 2091, 2092.

Advantage of, to a well-appointed school, 2118.

*Honours.*

Taken in Plymouth Science School, 2064, 2072, 2073.

*Mathematics.*

Taught in Plymouth schools, 2096.

*Meteorology.*

Should be taught in science schools, 2064, 2111.

*Navigation and Nautical Astronomy.*

Not fairly treated in Plymouth Navigation School; remedy suggested, 2053–2055.

*Navigation School.* See *Plymouth Navigation School*.

*Original Research.*

In science, a national concern; should be paid for by Government, 2121.

*Payments by Results.*

In Plymouth science schools, 2064, 2093, 2128.

Not allowed in respect of dockyard pupils, 2076, 2077.

*Per-centage.*

Of subjects taught in Plymouth science schools, 2064–2068, 2122, 2123.

*Physical Astronomy.*

Should be taught in science schools, 2064, 2111.

*Plymouth Charles School.* See *Charles Science School*.

*Plymouth Navigation School.*

Its status, number of students, examinations, defects, &c., 2051–2062, 2064.

Little local interest taken in, 2133.

*Plymouth Science School.*

Founded with difficulty; its rapid increase; want of accommodation in; statement respecting, delivered in, 2063–2065.

Number of papers worked in, and per-centage of successes, 2066–2070.

Honours taken by students in, 2073.

Chiefly attended by mechanics, 2108.

Committee of, not supported by Science and Art Department, 2124–2127.

Little local interest taken in, 2133–2135.

Programme of, for 1869–70, 2135.

*Royal School of Naval Architecture.*

Failure in examination of pupils from, 2078–2083.

*Scholarships, Science and Art.*

To pupils connected with elementary schools, 2100–2103.

*Science and Art Department.*

System of, has given a preliminary impetus to study of science, 2084.

Scholarships granted by, 2100–2103.

Refusal of, to interfere with Plymouth Science School, 2124.

*Science Classes.*

Number of, and masters, in Plymouth, 2087.

*Science Schools.*

Suggestions for improvement of, 2064, 2089a, 2090, 2104.

Laxity of interest in, in Plymouth, 2101, 2133.

*Science Students.*

Number of, in Plymouth Navigation School, 2052.

Increase of, in Plymouth Science School, 2064.

*Science Teachers.*

In Plymouth schools, 2064.

Failure in examination of some, 2078–2083.

At present, not fit for their office, 2085–2087.

Their payment and duties, 2092–2097, 2104–2107.

In Plymouth, not well followed, 2108–2110.

Examination of, should be more severe, 2115.

Should receive salaries from Government, 2117–2120.



SHORE, THOMAS WILLIAM, Esq. (Index of his Evidence.)

*Age of Science Students.*

In witness's classes, students are from 16 to 20 years, 2155, 2274.

Physical geography may be taught to boys of 10 years, 2276.

*Apparatus for Science Purposes.*

Fair amount of, in institutions under East Lancashire Union, 2154.

Grant now offered by Department for small laboratories, &c., 2154.

*Artizans.*

Benefits derived by artizans from science classes, 2228–2230.

Contributions of artizans to educational institutions, 2239.

*Bradley, Professor.*

Statement of, respecting teachers; rejections of candidates by, 2199–2203, 2264.

*Certificates or Diplomas.*

A science diploma, with stipend attached, desirable for science teachers, 2153, 2218–2222.

*Chemistry.*

Good apparatus for teaching, in East Lancashire, 2154.

Grant now offered by Department for laboratories; great improvement will result from this, 2154, 2260.

*Children.*

Value of evening classes for youths, 2210.

Physical geography may be taught to children at 10 years, 2276.

Science, under Department scheme, cannot be taught to children, 2277.

*Contributions for Science Purposes.*

A few subscriptions only have been given by East Lancashire manufacturers, 2163–2165, 2167.

Contributions of artizans to educational institutions, 2239.

*Cramming.*

Written examinations tend to cramming; no remedy but oral examination, 2246–2254.

*Directory (Science and Art).*

On grants, 2155. Allowance for teachers visiting London, 2174. Growth and decay of science classes in Ireland, 2183.

*Education Department.*

Want of confidence engendered by changes in, 2152, 2284–2287.

Opposition of, to Science and Art Department, respecting science in elementary schools, 2278–2284.

*Elementary Schools.*

Science instruction for certificated masters of, 2149.

Advanced pupils of, drafted into science classes, 2151, 2152.

Science instruction in; that formerly given has been done away with by Revised Code, 2276–2284.

*English Language.*

Instruction under East Lancashire Union is based upon a thorough knowledge of the English language, 2145, 2150, 2155, 2184.

*Evening Classes.* See *Science Classes.*

*Fees.*

Paid by students, under East Lancashire Union, 2155.

High scale of fees recommended by Department, 2155.

*Foster, Dr.*

Lectures by, on practical teaching of physiology, 2155.

*Geometry.*

Numerous rejections in geometry this year, 2199–2203.

*Government Grants in aid of Science.*

Allowances to teachers for coming to London for instruction, 2174–2177.

Recent increase in; should be confined to best schools and localities, 2180–2182.

Would not be limited by requiring science students under 21 to pass a literary examination, 2185–2191.

*Ireland.*

Science classes in, which originated rapidly, and failed, 2183.

*Laboratories.*

Grants now offered by Department for laboratories; great improvement will result from this, 2154, 2260.

Science teachers invited to London for laboratory instruction, 2177.

SHORE, T. W., Esq.—cont.

*Lancashire (East).*

Witness's duties, remuneration, &c., in connexion with East Lancashire Union of Evening Schools, 2136–2150, 2156–2160, 2171.

Science in North-east Lancashire, 2151; beyond standard vi., 2155.

Enumeration of institutions in, well adapted for educational purposes, 2162.

Little local interest in science in, 2163–2165, 2231–2233, 2236–2239.

Formerly two organising masters under Union, now but one; room for three, 2166–2173, 2179.

Little encouragement in, to establish secondary schools, 2238–2245.

List of science schools in, 2287.

*London.*

Department teachers going for instruction to London, a good plan in the main, 2174–2177.

*Manufacturers.*

Little encouragement given by, to science teaching in East Lancashire, 2163–2165, 2231–2233, 2236–2239.

*Mathematics.*

Objection to certificated teachers having to pass in stage i. of, 2153, 2215–2217.

*Mechanics' Institutes in East Lancashire.*

Organisation of classes; inspection; instruction; students, &c., in, 2136–2151, 2155, 2161.

Good institutions at Burnley, Haslingden, and Bacup, 2162.

See *Science Classes.*

*Organising Masters.*

Formerly two under East Lancashire Union; now but one; room for three, 2166–2173, 2179.

*Payments on Results.*

Amounts received for, in classes under East Lancashire Union, 2142.

Evils of cramming for the sake of, 2246–2254.

*Per-centages.*

Of students connected with East Lancashire Union who pass examinations, 2155.

*Physical Geography.*

May be taught to boys of 10 years, 2276.

*Physiology.*

Dr. Foster's lectures on practical teaching of, 2155.

Improvement in teaching animal physiology this year, 2260.

Teachers formerly used diagrams only, 2265, 2266.

*Practical Instruction.*

Good appliances for giving, under East Lancashire Union, 2154.

Present system of examination affords little encouragement for practical work or teaching, 2154.

Dr. Foster's lectures on practical teaching of physiology, 2155.

Most desirable for teachers, 2260–2266.

*Revised Code.*

Standard vi. passed more than once by advanced pupils who enter science classes, 2151, 2152.

Want of confidence engendered by changes in, 2152, 2286.

Science teaching in primary schools done away by, 2278.

*Schoolmasters.*

Science classes for certificated schoolmasters lately opened; favourable time now for establishing such, 2149, 2152, 2160, 2207–2210.

*Science.*

Subjects of, number of students, &c., taught in Lancashire, 2144–2151.

Age for receiving first instruction in, 2155, 2274, 2276.

Witness's early science training, certificates, teaching, &c., 2156–2160.

Little encouragement given to, by manufacturers in East Lancashire, 2163–2165, 2231–2233.

Practical instruction in, most desirable for teachers, 2260–2266.

Instruction in London to Department teachers; a good plan, but should be confined to teachers' own subjects, 2174–2177.

Subdivision of science subjects desirable, 2179.

Suggestions to Department respecting science teaching, 2206.

Small amount of science taught in training colleges, 2211–2213.



SHORE, T. W., Esq.—cont.

*Science and Art Department.*

- Payments by, to East Lancashire Union classes, 2142.
- Changes of, and want of confidence in, by science teachers, 2152, 2285–2287.
- Objections in examination system pointed out to, 2153, 2154.
- Subdivision of subjects of examination by, 2153, 2256.
- Grants for laboratories now offered by, will effect great improvement, 2154.
- High scale of students' fees recommended by, 2155.
- Aid to organising masters by, 2169, 2170.
- Instruction of teachers in London by; a good plan in the main, 2174–2177.
- No harm would result if a literary examination were required by, for science students under 21 years, 2185–2191.
- Disapproval of abolition by, of special examinations for teachers, 2196–2206.
- Report to, after visiting Paris Exhibition, 2206.
- Practice of cramming under, 2246, 2254.
- Children cannot be taught under system of, 2277.
- Opposition of, to Education Department, 2278–2284.

*Science Classes.*

- Under East Lancashire Union, 2136–2150, 2151.
- On Saturday mornings, for schoolmasters; day classes generally would fail, 2149, 2160, 2161.
- A favourable time now for instituting science classes for schoolmasters, 2152, 2207–2210.
- Value of evening classes for youths, 2210.
- Advantages derived by artisans from, 2228–2230.
- Classes which have opened for a short time only, and failed, 2183, 2184.
- List of science schools in north-east Lancashire, 2287.

*Science Examinations.*

- Tendency of Department to subdivide subjects of, 2153, 2256.
- Objection to certificated teachers having to pass in stage I. of mathematics, 2153, 2215–2217.
- Desirability of a low standard for; variation in standards, 2155, 2267–2272.
- Per-centage of students who pass in institutions under East Lancashire Union, 2155.
- One teacher should not undergo many examinations, 2179, 2218.
- Abolition of special examination for teachers has produced an inferior class, 2196–2206, 2220.
- Written examinations tend to cramming; oral examination by science inspector, and raising examination of teacher, the only remedy, 2246–2256.
- Approval of candidate passing elementary before advanced stage, 2258, 2259.

*Science Inspectors.*

- Oral examination by, might prevent cramming, 2246–2254.

*Science Schools.* See *Science Classes.*

*Science Students.*

- Number of, under East Lancashire Union, 2145–2148.
- Instruction for certificated masters, 2149.
- Advanced pupils who pass standard VI. are drafted into science classes, 2152.
- Students are from 16 to 20 years of age in witness's classes, 2155, 2274.
- Per-centage of, who pass examinations, 2155.
- Educational standard of, and fees paid by, 2155.
- A literary examination for, would do no harm, 2185–2191.
- Advantages derived by artizan students from science classes, 2228–2230.
- Cramming of, for payments on results, 2246–2254.
- Approval of students passing elementary before advanced stage, 2258, 2259.
- Boys of 10 years can learn physical geography, 2276.

*Science Teachers.*

- Duties, &c. of witness as teacher, &c., under East Lancashire Union, 2136–2150, 2156–2160, 2171.
- Number and duties of teachers in North-east Lancashire, 2151–2154.
- Want of confidence of, through changes in Department, 2152, 2284–2287.
- Objection to certificated teachers having to pass in stage I. of mathematics, 2153, 2215–2217.
- A science diploma, with stipend, desirable for, 2153, 2218–2222.
- Instances of first class in chemistry obtained by, from book-work only, 2153.
- Approval of Department bringing teachers to London for instruction, but instruction should be confined to teachers' own subjects, 2174–2177.

SHORE, T. W., Esq.—*Science Teachers*—cont.

- One teacher should not take many subjects 2179, 2218.
- Occupations, other than that of schoolmaster, of science teachers, 2192. They usually throw up other occupations for science teaching, 2194, 2195.
- An inferior class of, produced by abolition of special examination, 2196, 2197.
- Disapproval of some teachers' qualifications, 2198–2206.
- Older teachers would not lose habit of teaching up to stage I., 2214–2217.
- Special training college for, desirable, 2225, 2226.
- Raising examination of, might check cramming, 2255.
- Practical instruction most desirable for, 2260–2266.

*Secondary Schools.*

- In East Lancashire; little encouragement to establish them, 2163–2165, 2238–2245.

*Training Colleges.*

- Small amount of science taught in, 2211–2213.
- Special college for teachers desirable, 2225, 2226.
- Present colleges are denominational or semi-denominational, 2227.

SMYTH, WARINGTON W., Esq., F.R.S. (Index of his Evidence.)

*Accommodation for Science Purposes.*

- A professor of mineralogy and mining at South Kensington would require space for mineral specimens for lecturing purposes, and also for the exhibition of a large mineral collection, and for specimens illustrating the occurrence of minerals in the lodes, 7441–7445.
- A mineralogical collection would perhaps at first require a room 30 feet by 20; a smaller room would do for the mineral lodes, 7446.
- There should also be space for mining plans, and a scientific library, 7447.

*Age of Children.* See *Children.*

*Agents.*

- Applications are frequently made at School of Mines to recommend agents for inspecting mineral properties, 2318, 2419.

*Alais (France).*

- Mining school at, intended for foremen. Excellent men have been turned out from there, 2377.

*Algebra.*

- A student of mineralogy should have some previous knowledge of algebra, 2460.

*Apprenticeship.*

- Objection of colliery viewers to allow courses of School of Mines to be substituted for, 2335, 2424.
- It would be important, if, as done in a few cases, apprenticeship and science instruction could be combined 2426, 2427.

*Artizans.*

- Science schools should correspond to the varied requirements of, 2376. Schools in France, Germany, &c. do this, 2377–2379.
- See also *Miners.*

*Assessment for Science Purposes.*

- Might be made on mining property for establishing science schools, if voluntary aid were not offered, 2449, 2450.
- Desirability of assessment of shareholders of mines in Cornwall and Staffordshire, 2451–2453, 2465.
- In certain districts of Cornwall and Newcastle compulsory assessment would be little needed, 2465, 2466.

*Austria.*

- Mining schools of, at Schemnitz, Leoben, and Przibram.
- A central school now proposed to be at Vienna, 2325.

*Berlin.*

- Central mining school at, 2325. It is largely endowed by the State; but (as at School of Mines) economy in payment of professors is effected by union with the Geological Survey, 2456.

*Bristol.*

- There is an excellent mining school attached to a trade school at, 2301, 2306, 2307.
- Young men from Swansea have attended the Bristol mining school, 2364.

*British Museum.*

- Either the mineral collection from the British Museum should be near the School of Mines, if carried on at South Kensington, or else a full and well-arranged collection, 7444. This arrangement would answer for the simple minerals; there would be required as well specimens illustrating the occurrence of minerals in the rocks, 7445.



SMYTH, W. W., Esq.—*British Museum*—cont.

Advantage to School of Mines' students, after studying the minerals in Jermyn Street, of inspecting, in the British Museum, a collection arranged upon a totally different system, 7447.

*Chemistry.*

School of Mines' students should have a knowledge of, before coming up for mineralogy and mining, 2434, 2446, 2460.

They are usually well prepared in chemistry by having passed through Dr. Frankland's courses, 2461.

*Children.*

Among the children of miners about one sixth cannot read and write, 2415.

If kept at school beyond 12, they would be indisposed to work in mines, and would suffer materially as workmen, 2416, 2417.

Attendance at night schools might be made obligatory up to 16, as a condition of employment, 2418.

*Civil Engineers' College.*

Feeling exhibited by civil engineers at time of erection of, 2424, 2425.

*Clausthal.*

Mining academy and mining school at, 2325.

*Coal.*

Great waste in working, in Staffordshire, 2391. In point of economy, science should be promoted in that district, 2452, 2453.

*Collieries.*

Managers of, are usually trained in engineers' offices, 2335.

*Colliery Viewers.*

Objection of, to allow courses of School of Mines to be substituted for apprenticeship to themselves, 2335, 2424.

Some apprentices of, have studied at School of Mines, 2426, 2427.

Mining inspectors are all chosen from, 2459.

*Contributions in aid of Science.*

Voluntary contributions in aid of science schools might be expected from persons connected with mining, 2447, 2448.

If not made, assessment would be desirable, 2449–2455.

In some districts of Cornwall and in the Newcastle district handsome offers have been made to endow science schools, 2465.

*Copper and Zinc Mines and Works.*

Engagement of foreigners as managers, &c. in works in Wales, &c., 2367, 2368. The School of Mines is now supplying managers, 2369.

Many valuable scientific processes for utilizing lean ores in English works have originated on the continent, 2392, 2393. One of these processes has been most successfully adopted, in treating refuse copper-ores, by a student of the School of Mines, 2393, 2394.

Great depression in connexion with the copper mines of Cornwall. A diffusion of scientific knowledge might lessen the difficulty, 2345–2351.

*Cornwall.*

Technical school in, called the Association of Miners of Cornwall and Devonshire, 2301, 2302.

Managers of mines in, are usually raised from the ranks, 2334.

School of Mines' students occasionally taken to Cornwall by lecturer, or furnished with introductions to his assistant there, 2341.

Magnitude and importance of mines in, 2343.

Copper mining in, is depressed by production of copper-ore in South America, but tin-ore has made up for it in some measure, 2345–2348.

Difficulties in working mines in, might be overcome by scientific methods, 2349.

The want of scientific knowledge in Cornwall is beginning to be strongly felt there, and is necessary at the present time, 2350, 2351.

Great efforts have been made to establish science schools in, 2361.

Many mineral owners have subscribed to the schools, but not shareholders in mines generally, 2362, 2363.

The superior class of workmen avail themselves of the mining school there, 2407. Practical work is combined with theoretical instruction, 2411. The classes are generally held in the evening, 2412–2414.

Shareholders of mines in, should be assessed for support of mining schools, 2451, 2454, 2465.

## SMYTH, W. W., Esq.—cont.

*Daglish, Mr.*

Allusion to information obtained from, respecting contributions of employers to science schools, 2304.

*Diagrams.*

Less convenient than models for explaining certain pieces of machinery. Much machinery may be explained by diagrams, 7451.

*École des Mines, Paris.*

Is intended for mining engineers, 2378.

Receives a large sum from the State, 2463.

*Economy.*

In the School of Mines (as in the central school at Berlin) much economy is effected by union with the Geological Survey, 2456.

*Education.*

Different amount of, required by different classes of workmen, 2308.

Education of all might be conducted together to a certain point, 2309.

Comparison of English miners (managers and workmen) educationally with those of France and Germany, 2400–2402.

A more general diffusion of, desirable, so as to make individual cases less remarkable, 2409.

Practical work should be combined with theoretical instruction, 2410.

A large proportion of Cornish miners cannot read and write. Of their children, about one sixth cannot read and write, 2415.

Elementary education extended beyond 12 years of age would indispose boys to work in mines, and would injure them as workmen, 2416, 2417.

*Elementary Schools.*

Mining and mineralogy are not subjects for, except in certain districts, 2295–2297.

Applied subjects should not be taught in, 2305.

*Employers.*

Not unwilling to assist in forming science classes, 2303.

*England.*

Comparison of miners (managers and workmen) of England with those of France and Germany, in respect of education, 2400–2402.

*Evening Classes.*

In Cornwall, the classes are generally held in the evening, 2412–2414.

Attendance at, might be made compulsory, up to 16, as a condition of being allowed to work, 2418.

See *Mining Schools*.

*Foreigners.*

Engagement of, as managers, &c., in South Wales smelting works, 2367.

Twenty-five years ago Mr. Vivian engaged assistants from Freiberg. Men could not be got in England who had passed through the same courses, 2368.

Engaged now to a less extent. The School of Mines is now supplying managers, 2369.

*France.*

Schools specially for workmen in, 2377.

*Frankland, Dr.*

Most School of Mines' students in mining and mineralogy have previously passed through Dr. Frankland's chemical course, 2461.

*Freiberg (Royal Mining Academy).*

Witness formerly studied at, and has recently visited, this academy, 2324.

Engagement by Mr. Vivian of assistants from, 2368.

The academy is wholly supported by the State. A portion of the money is repaid from students' fees, but the expenses are very considerable, 2456.

Schedule of subjects taught and names of lecturers at the academy, 2467.

*Geography.*

A student of mineralogy should come prepared with some knowledge of geography, 2460.

*Geological Survey of the United Kingdom.*

Many students of Royal School of Mines employed in, 2333.

Economy effected (as in Berlin) by the union of the School of Mines with the Geological Survey, 2456.

*Geometry.*

A student of mineralogy should have some previous knowledge of geometry, 2460.



SMYTH, W. W.—cont.

*Germany.*

Schools specially for workmen in, 2379.

In colleges of, courses are frequently divided into a preliminary course, and a group of technical subjects, 2435.

See *Berlin. Freiberg.*

*Glasgow.*

Technical school started at, which has failed, 2302.

*Government.*

A scheme for establishing mining schools, authorized by Government, and sanctioned by persons of local experience, might stimulate voluntary contributions, 2448.

Little hope of this, unless Government influence is used, 2455.

*Government Grants in aid of Science.*

The only aid given to technical schools is by payment on results, 2300.

Continental mining academies receive a large sum from the State, 2463.

*Great Britain.*

Before the opening of the Jermyn Street Museum no public institution represented the mineral wealth of Britain, 2315.

*Home Office.*

Mining inspectors appointed by, must have had long practical experience in management of a coal mine, 2459.

*Isle of Man.*

Managers of mines in, are usually raised from the ranks, 2335.

*Jermyn Street Institution.*

Origin of the courses on mineralogy and mining given in, 2314.

Up to time of opening museum in, there was no public institution which represented the mineral wealth of Britain. Its aim and scope is different from any other, 2315.

Many foreign technical visitors have been there, 2316.

The collection has been spoken of in the highest terms by Von Cotta, Signor Sella, Professors Rockwell and Brush, &c., 2317.

Men of all classes come to it for gratuitous advice respecting minerals or mining matters, and for recommendations of experienced agents for inspecting properties at home and abroad, 2318, 2319.

Favourable opinion entertained among mining people of School of Mines in, 2320.

Position of, favourable to attainment of high scientific instruction, 2322.

Valuable technical library in, 7448.

See *Geological Survey. Royal School of Mines.*

*Leuschner, M.*

High opinion of English mining workmen expressed by, 2402.

*Library of the Jermyn Street Institution.*

A most valuable technical library there, 7448.

*London.*

Advantage of position of central mining school in, with regard to attainment of high scientific instruction, 2322.

*Machinery.*

Models more convenient than diagrams in teaching certain machinery; though much machinery may be explained by aid of diagrams, 7451, 7452.

*Mathematics.*

It is thought the School of Mines might dispense with teaching mathematics, there being so many places where such instruction can be obtained; but students come with small amount of preparation in that subject, 2422, 2423.

*Mineralogy and Mining.*

The number of candidates in Department examinations in, has increased, but not largely, 2290. Number of candidates passed and rejected in, 2293.

Interest in, is mostly restricted to certain places, 2294. Not suited for general schools, except in special districts. Mineralogy can only be taught in schools where boys remain over 12, 2295–2297.

Great improvement in examination papers in, 2298.

Tendency to localize study of, shown in some examination papers; this applies less to mineralogy than to mining, 2310, 2312, 2395, 2396.

Origin of lectures on, given at Jermyn Street, 2314.

List of students who have been examined in, in the School of Mines, 2333.

26060.

SMYTH, W. W.—*Mineralogy and Mining*—cont.

Qualifications of students in mining cannot be ascertained by the Department examinations, 2352–2354.

School of Mines' students should enter with some practical knowledge of mining, and also of general science, 2433, 2434.

Mining needs practical observation; mineralogy requires some previous knowledge of geometry, algebra, geography, and chemistry, 2460.

School of Mines' students of, usually come well prepared in chemistry, having passed through Dr. Frankland's courses, 2461, 2462.

For teaching, at South Kensington, rooms would be required for lecture specimens, for a large and well-arranged collection of minerals and specimens illustrating the occurrence of minerals in rocks, or models, mining plans, &c., 7441–7447.

Either the British Museum collection of minerals should be near the school, or a large collection formed there, 7447.

Besides the School of Mines' collection, students derive great advantage from studying the British Museum mineralogy specimens, which are arranged on a totally different system, 7444–7447.

See *Mining.*

*Miners (Managers and Workmen).*

Many School of Mines' students have of late become managers of mines, 2369.

Compared with those on the continent, our managers are inferior in general acquirements, but often make up for it in energy and practical knowledge; while our workmen are superior in practical knowledge and skill, 2400, 2401.

The energy of our managers would not be diminished if they were better instructed, 2402.

High opinion of M. Leuschner respecting English mining workmen, 2402.

On economical considerations, our managers should be educated, 2403.

Education of managers by a central school would be a slow process; but advanced secondary instruction placed within their reach would be most beneficial, 2404, 2405.

The superior class of workmen would be likely to avail themselves of instruction brought within their reach. The Cornish mining school is confirmatory of this, 2406, 2407.

While the better educated men remain rare cases, they are likely to forego handiwork, and become clerks, &c. Secondary schools would correct this, 2407, 2408.

The proportion of workmen who cannot read and write is large; of children, the proportion is about one sixth, 2415.

Boys kept at school beyond 11 or 12 years of age would be indisposed to work in mines, 2416. If their schooling were extended to 13 years, they would suffer materially as workmen, 2417. Night schools might be made obligatory up to 16, as a condition of being allowed to work, 2418.

Should have scientific instruction in the locality where the mines are. This might be given in secondary schools, 2437.

*Mines.*

Many School of Mines' students have of late obtained position of manager of, 2369.

General science instruction for miners should be given in locality of mines, 2437.

Assessments on, might be made for establishing science schools, 2449–2453, 2464, 2465.

In Prussia, mines are not much worked by, but minerals are taken under lease from the Government; a large staff being required. Most students of mining schools get appointments connected with mining, 2326–2328.

*Mining.*

Was added as a separate branch of examination in 1861, in consequence of an application to the Department from certain ex-students of Jermyn Street, who taught it in the country, 2291, 2292.

Number of candidates passed and rejected in, 2293.

Small number of candidates accounted for by the interest in mining being confined to certain districts, the different requirements of different districts, and difficulty in obtaining proper teachers, 2294.

Not a subject for general schools, except in certain districts, 2295–2297.

Improvement in examination papers, and tendency shown to localize the study, 2298, 2310, 2312, 2313.

Origin of lectures on, given at Jermyn Street, 2314.

Models illustrative of, in Jermyn Street Museum, 2315.



SMYTH, W. W.—*Mining*—cont.

Jermyn Street institution resorted to for gratuitous information on mining matters, 2318.

In metalliferous mine districts, managers are usually raised from the ranks; in colliery districts, engineers take pupils into their offices. This is why School of Mines' students have seldom become managers of mines, 2334, 2335.

Great advantage to School of Mines' students from lecturer's connexion with mining, 2340.

Acquaintance with science of, highly important in selection and working of mines, 2344.

Students of mining or other technical subjects cannot properly be tested by Department examinations, 2352–2354.

Difficulty of giving science instruction in outlying mining districts, 2358–2360.

Greater intercommunication between different mining districts is much wanted, 2395, 2396.

Diversity of practice in mining in different districts, 2397.

The rule-of-thumb prevails in many districts, 2398. This is prejudicial to safety. Danger of prevalent custom of making plans upon the magnetic, instead of the true meridian, 2399.

The study of, needs practical observation, 2460.

Space required for a professor at South Kensington, 7441–7447.

See *Cornwall. Staffordshire. Mineralogy and Mining, &c.*

*Mining Engineers.*

Objections of, to allow courses of School of Mines to be substituted for an apprenticeship, 2424.

*Mining Inspectors.*

No connexion between, and School of Mines. Before appointment they must have managed a coal mine for a certain number of years, 2457, 2459.

*Mining Record Office.*

In connexion with Geological Survey, &c., of great value to School of Mines' students, 2341.

*Mining Schools.*

Allusion to mining schools in Cornwall, Glasgow, &c., 2301, 2302.

Tendency in certain of them to localize their studies. This can only be corrected by keeping them in connexion with a central establishment, 2310.

Great efforts have been made in Cornwall to establish, 2361.

Mineral owners, but rarely shareholders in mines, have subscribed to these schools, 2362, 2363.

One has been talked of for Swansea, 2364.

Should correspond with requirements of various classes of workmen, 2376. This is the practice in France, Germany, &c., 2377–2379.

The second-grade mining schools should be largely supported by voluntary contributions, 2383. Indifference of mine owners in this matter, 2384.

The assistance given by South Kensington to, was unknown till lately to many of the leading mine owners, 2386.

No mining or metallurgical district on the continent of equal extent to North and South Staffordshire is without a mining school, 2388, 2389.

Secondary schools in their own localities more adapted to managers and workmen than a central school, 2404, 2405.

Superior workmen would avail themselves of these institutions, 2406.

They would check the present tendency of the best men to leave their handiwork, and become clerks, &c., 2407, 2408.

In the mining schools in Prussia and in Cornwall practical work is combined with theoretical instruction, 2411.

In Cornwall the classes are generally held in the evening, 2412; the students having been working practically during the day, 2412–2414.

General and underground surveying should be especially taught in, 2420, 2429.

If established in mining districts, apprenticeships could be combined with theoretical courses, and underground surveying might be thoroughly taught, 2428, 2429.

If several were established at once, teachers would be difficult to be got; but, if done at intervals, the difficulty would disappear, 2430–2432.

If a scheme, authorised by Government, and sanctioned by persons of local experience, were put before mine proprietors, &c., voluntary contributions might be expected, 2447, 2448.

SMYTH, W. W.—*Mining Schools*—cont.

If voluntary aid were not forthcoming, an assessment on mining property might be made. In some districts pressure would be indispensable, 2449, 2454, 2465.

Little hope of establishing, without Government influence is brought to bear upon the districts, 2455.

In Prussia they are endowed by the State, 2456.

In Cornwall and the Newcastle district there is a great feeling for establishing mining schools, 2465, 2466.

*Mining Schools (Continental).*

Curriculum of, generally more extensive than our own, 2325.

In Prussia, with a mining population about half our own, there are two mining academies, nine mining schools, and nine preparatory schools. Full list of same, 2325.

Most of the students in, get appointments in mines, 2327, 2328.

Good technical training given in, 2329. Intended for students who have passed through other schools, 2330.

Moderately stiff examination for entering, 2331.

In Prussia, they are mostly separate from, and intended for students who have passed through, the polytechnic schools, 2330.

The central schools or academies receive a large sum from the State, 2463.

*Models.*

More convenient than diagrams for teaching certain pieces of machinery; though much machinery may be explained by diagrams, 7451.

*Museum of Practical Geology.*

Up to the time of opening this museum, there was no public institution which represented the mineral wealth of Britain, 2315.

*Newcastle.*

Recent attempt to get up science classes at; but, in consequence of an alteration in payments by Department, its success is doubtful, 2302.

There is a great feeling in favour of establishing science classes in the Newcastle district; many persons would probably subscribe, 2465, 2466.

*North of England Institute of Mining Engineers.*

Active part recently taken by, respecting the establishment of a mining school, 2385.

*Payments on Results.*

The only State aid given to technical schools, 2300.

*Physics.*

School of Mines' students should have a knowledge of physics before coming up for mining, 2434.

*Polytechnic Schools.*

Mining schools in Prussia not connected with, but intended for students who have passed through, polytechnic schools, 2330.

*Practical Instruction.*

Practical knowledge generally possessed by English managers and workmen of mines, 2400, 2401.

In education, practical and theoretical work should be combined; this is done in the mining schools of Cornwall and Prussia, 2410, 2411–2414.

School of Mines' students generally learn the practical part of their business after leaving the school. A few come prepared with practical knowledge, which is desirable, 2336, 2337. They are occasionally taken to Cornwall by mining lecturer, or furnished with introductions to managers there, 2341.

Importance of a knowledge of underground surveying, which must be practically acquired in the mine, 2420, 2421.

Technical instruction, even when unaccompanied with real practice, is an advantage, 2438, 2439.

Practical experience in management of a coal mine must have been had by all Government mining inspectors, 2459.

Practical observation is essential for the study of mining, 2460.

*Prussia.*

Twenty mining schools in. List of the same, 2325. Excellent technical training in these schools, 2329, 2379.

Mines in, not much worked by, but minerals taken under leases from, Government; a large staff being required, 2326.

A large proportion of mining students in, get appointments in mines, 2327, 2328.

In the mining schools of, practical and theoretical work are combined, 2411. These schools are endowed by the State, 2456.



SMYTH, W. W.—cont.

*Royal School of Mines.*

Favourable opinions respecting the school are generally entertained by men connected with mines, 2320.

It is in a good position as a central school, in respect of the higher scientific instruction which may be expected at head-quarters, 2322.

It labours under the disadvantage of being a new institution, 2372. A school of the kind requires two or three generations to get known, 2373.

To educate mining managers in, would be a slow process, 2404.

There should be a class in, for general and underground surveying, 2420, 2421.

Mathematics have not been taught in, there being so many places for obtaining such instruction, 2422.

Objections of mining engineers to allow courses of, to be substituted for apprenticeships, 2424. It would be important if the courses could be combined with apprenticeship; this has been done in a few cases, 2426, 2427.

Chemistry may be considered as a preliminary subject in, 2434, 2446.

If the courses in, were confined to purely technical instruction (and to a certain extent that plan is now adopted), though it might give a slight check at first, the supply of students would not be limited by it eventually, 2440–2445.

Economy is effected (as in Berlin) by union of the School of Mines with the Geological Survey, 2456.

Mining inspectors are in no way connected with, 2457.

Remark made by witness that he could not remain a teacher at School of Mines if the school were removed to Kensington, 7440.

Amount of space which would be required for the professor of mineralogy and mining if the school were removed to South Kensington, 7441–7447.

See also *Jermyn Street Institution*.

*Royal School of Mines' Students.*

List of those who have passed examinations in mineralogy and mining, with positions subsequently attained by them. Satisfactory nature of the list, 2333.

Not many are managers of mines. Reasons given for this, which are of different kinds in different mining districts, 2334, 2335.

They generally learn after leaving the school the practical part of their business, 2336.

A few have come prepared with practical knowledge, and it would be better if more came so prepared, 2336, 2337.

A larger number of, may be expected, when advantages of the school become better known, 2338.

There has been a larger attendance of practical men the last few years, 2339.

Great advantage to the students that they should be brought in contact with the lecturer, 2340.

The connexion of the school with the Geological Survey and Mining Record Office, and position of the lecturer with respect to the mines of the Prince of Wales and those under the Woods and Forests, is of great value to the students, 2340.

They occasionally accompany the lecturer to Cornwall, or are furnished with letters to his assistant there, 2341.

Many have become managers of mines, &c.; positions formerly held by foreigners, 2369.

One is now engaged, under Mr. Siemens, in applying regenerative furnaces to steel-making, at Landore, 2370.

They enter mostly with small amount of preparation in mathematics, 2422, 2423.

Desirable for mining students to have some practical knowledge of mining, and acquaintance with general science, before coming up for the applied portions, 2433–2435.

The supply of mining students would not eventually be limited if courses were confined to technical instruction, 2440–2445.

Do not obtain post of mining inspectors; a certain number of years' practical management of a coal mine being essential for this office, 2458, 2459.

Most of those coming up for mineralogy are well prepared in chemistry previously by Dr. Frankland, 2461, 2462.

Necessity of having a well-arranged collection of minerals for, 7442–7444.

At present, the students of mineralogy, besides the Jermyn Street collection, have the advantage of studying, in the British Museum, a collection arranged upon a totally different system, 7447.

SMYTH, W. W.—cont.

*Science and Art Department.*

Assistance given by, to mining schools, unknown till lately to many leading miners, 2386.

See *South Kensington. Science Examinations, &c.*

*Science Classes.* See *Mining Schools*.

*Science Examinations.*

Increased number of candidates in Department examinations in mining and mineralogy, 2290.

Mining was added, in 1861, as a separate branch of, 2291, 2292.

Qualifications of pupils in mining or other technical subjects cannot be satisfactorily ascertained by Department examinations, 2352–2354. Care on examiners' part may somewhat counteract the difficulty, 2355.

*Viva voce* examinations in mining would be difficult to conduct, on account of the outlying position of the districts. The teaching in these districts is still more difficult, 2356–2360.

*Science Examination Papers.*

Great improvement in character of, with regard to mineralogy and mining, 2298.

Show a tendency in some places to localize studies, 2310, 2312, 2313. Certain of them bear evidence of having come from the neighbourhood of Wigan, 2375.

*Science Instruction.* See *Mining Schools, &c.*

*Science Teachers.*

It is difficult to get proper teachers of mining, 2294.

Can make a better income by remaining in large towns than by going to mining centres, 2302.

If large local colleges were erected there would be a difficulty at first in getting teachers, 2430–2432.

*Secondary Schools.* See *Mining Schools*.

*Siemens, Mr.*

His manager is a former student of the School of Mines, 2370.

*South America.*

Copper-ore of, has seriously depressed Cornish mining diffusion of scientific knowledge might lessen the difficulty, 2345–2351.

*South Kensington.*

If the School of Mines were removed to, witness had stated that he could not remain a teacher, 7440.

Opinion respecting amount of accommodation at, which would be required for a professor of mineralogy and mining, 7441–7447.

For mineralogy at, either the British Museum collection should be in a place near the School of Mines, or there should be space for a full and well-arranged collection of minerals accessible to students. There should also be space for a collection of specimens of mineral lodes, models, mining plans, and a scientific library, 7444–7447.

See *Science and Art Department. Science Examinations, &c.*

*Staffordshire.*

There is no mining or metallurgical district on the continent of equal extent to North and South Staffordshire without a mining school, 2388, 2389.

Minerals there are daily increasing in value. Special necessity for economy of working, 2390, 2391.

Waste in working the thick coal there, 2391, 2452.

Diversity of practice in mining operations between Staffordshire and the North of England districts, 2397–2399.

In point of economy, it is most essential that more science should be brought to bear upon the mining industry of Staffordshire. An assessment for that purpose desirable, 2452, 2453.

*Surveying.*

A class for, should be introduced at the School of Mines. Importance of a knowledge of underground surveying, which must be practically acquired in the mine, 2420, 2421.

*Technical Instruction.*

Excellent in Prussian mining schools, 2329.

Students' attainments in, cannot properly be tested by Department examinations, 2352–2354.

Is an advantage, even when unaccompanied with real practice, 2438, 2439.

If School of Mines were confined to, the supply of students would not eventually be limited by it, 2440–2445.

See *Mining Schools, &c.*



SMYTH, W. W.—cont.

*Technical Schools.*

Much wanted for teaching mining and mineralogy, 2299. Government aid not given to, except in payments on results, 2300.

Particulars of, at Glasgow, Cornwall, Newcastle, &c., 2301, 2302.

Difficulty of always separating, from primary ones. In some instances they might be taught by same master, 2305, 2306.

Mining school attached to a trade school at Bristol, 2306, 2307.

See *Mining Schools*, &c.

*"Times."*

Remarks of witness on a letter in the "Times," containing statements implying personal motives, 7440.

*Trades' School.*

Mining school attached to a trades' school at Bristol, 2306, 2307.

*Truro.*

Technical school at, 2301, 2302.

*Vienna.*

Proposed establishment of a central mining school at, 2325.

*Virian, Mr.*

Formerly obliged to engage assistants from Freiberg, because men who had passed through the same courses could not be got in England, 2368.

*Wales.*

In West Wales managers of mines are usually raised from the ranks, 2335.

Managers, &c. of smelting works in South Wales have been formerly engaged from the continent, 2367, 2368. This occurs less frequently; the School of Mines is now supplying managers, 2369.

*Wigan.*

Allusion to examination papers bearing evidence of having come from the neighbourhood of Wigan, 2375.

MURCHISON, SIR RODERICK I., BART., K.C.B.  
(Index of his Evidence.)

*Accommodation for Science Purposes.*

Desirable to enlarge Jermyn Street institution by addition of two houses in Jermyn Street; one house specified, 2472, 2473.

A small additional space would satisfy the professor of metallurgy, 2472, 2473, 2476, 2492.

More laboratory room is desired in Oxford Street by professor of chemistry, to instruct a larger number of persons, 2476, 2477.

It would not be necessary to pull down and rebuild the additional buildings suggested for Jermyn Street institution, 2492.

Office room urgently wanted by the geological surveyors, to construct their maps, &c., 2492.

*Artizans.*

600 artizans attend the evening lectures in Jermyn Street; the abolition of which lectures would be an ungracious act, 2472.

*Ballarat Mining School.* See *Victoria.*

*Canada.*

A mining school, in connexion with the Geological Survey and Museum, is being projected in Canada, entirely upon the Jermyn Street plan, 2471.

*Chemistry.*

No school of mines complete without a chemist, 2473

Additional space, at College of Chemistry, has been desired by both the past and present professor, to instruct a greater number of persons, 2477.

Chemical analyses are required to be made during the progress of the Geological Survey; more should be done in that direction than has as yet been practicable, 2481, 2482.

*Cole, Henry, Esq., C.B.*

Allusion to Mr. Cole's memorandum in 1868, on removal of School of Mines, 2469, 2470, 2474-2476, 2483, 2485.

*Columbia College Mining School.* See *New York.*

*Council of Professors of Royal School of Mines.*

Their opinion has not been taken officially on the proposed removal of the school, 2480.

*Donnelly, Captain, R.E.*

Allusion to his evidence and memorandum, in 1868, respecting removal of School of Mines, 2469, 2484.

MURCHISON, SIR R.—cont.

*Frankland, Dr.*

Rock specimens are occasionally analyzed by, for Jermyn Street institution, 2473, 2482.

Desire of, for a larger laboratory, to instruct a greater number of persons, 2476, 2477.

Has always made analyses of Survey rock specimens when requested, 2482.

His opinion cited, that if the College of Chemistry were removed to South Kensington it might still be carried on as heretofore in conjunction with School of Mines, 2488.

*Geological Survey of the United Kingdom.*

Witness is director-general of the Geological Survey, and director of the Royal School of Mines, 2468.

Suggestion that houses in Jermyn Street be taken for Survey and Mining Record Offices, and for the professors who require more space, 2472, 2473.

A chemist to analyze rock specimens is essential during the progress of the Survey; more should be done in that direction than has yet been found practicable, 2473, 2481, 2482.

The Survey must have a palæontologist, 2473.

The Geological Survey is a great and progressing national institution, 2473.

Space for geological surveyors to construct their maps, &c. is urgently needed, 2492, 2493.

*Harvard College Mining School.* See *Massachusetts.*

*Hofmann, Professor.*

Rock specimens were occasionally analyzed by, for Jermyn Street institution, 2473, 2482.

Would have liked increased space in College of Chemistry to instruct a greater number of persons, 2477.

*House of Commons Select Committee,* 1868. See *Samuelson, Mr.*

*Jermyn Street Institution.*

Want of space in, would be met by adding two houses in Jermyn Street; one suitable house pointed out, not necessary to pull down and rebuild, 2472, 2473, 2492.

Advantage of the size and central position of the lecture-theatre in, which enables 600 artizans to attend the courses, 2472.

The institution has worked efficiently for nearly 20 years, and nothing but disadvantage could be attained by breaking down one branch of it, 2473.

See *Accommodation, Royal School of Mines*, &c.

*Laboratories.*

The School of Mines' professors of natural history and physics might have laboratories by adding two houses in Jermyn Street. Only a small additional accommodation is required by the professor of metallurgy, 2472, 2473, 2476, 2492.

The professor of chemistry would like more laboratory accommodation to instruct a greater number of persons, 2476, 2477.

*Lectures to Working Men.*

Through the size and central position of the lecture-theatre in Jermyn Street, 600 artizans are enabled to attend the courses. The abolition of these lectures would be an ungracious act to working men, 2472.

Allusions to witness's statement respecting the voluntary delivery of these lectures by the professors, 2486, 2487, 2472.

*Massachusetts.*

The School of Mining and Practical Geology at Harvard College has been established on the plan of the Royal School of Mines, 2471.

*Metallurgy.*

An essential branch of a school of mines, 2472, 2473.

A small additional accommodation in Jermyn Street would satisfy the professor of metallurgy, 2472, 2473, 2476, 2492.

*Metropolitan College of Science (proposed).*

The School of Mines will always serve its legitimate purpose if not commingled with other public teaching; but a great polytechnic school would be of importance in a general scheme of national education, 2473.

*Mining Record Office.*

Suggestion to provide a house in Jermyn Street for, together with Geological Survey, 2472, 2473.

*Museum of Practical Geology.*

Chemist and palæontologist essential officers in, 3473.

*New York.*

The School of Mines at Columbia College, New York, has been established on the plan of the Royal School of Mines, 2471.



MURCHISON, SIR R.—cont.

*Palæontologist.*

Essential in a school of mines, 2473.

*Percy, Dr.*

Only small additional accommodation in Jermyn Street required by, 2472, 2473, 2476.

*Royal College of Chemistry.*

More laboratory room in, desirable, to instruct a greater number of persons; but the chemical instruction given is enough for the wants of the School of Mines, 2476, 2477.

Dr. Frankland's opinion cited, that if the College of Chemistry were removed to Kensington it might still be carried on in conjunction with the School of Mines, 2488.

The College of Chemistry was removed from Jermyn Street for want of space; though more convenient if under same roof as School of Mines, the latter has gone on remarkably well since the separation, 2491.

*Royal School of Mines.*

Witness is director of the Royal School of Mines, 2468.

Protests against the scheme for breaking up the school, 2469. The abolition of the School of Mines, after nearly 20 years of successful teaching, would be a retrogressive step in the cultivation of science, 2471.

Instances cited of School of Mines forming a model for similar institutions in Canada, America, &c., 2471.

The addition of two houses in Jermyn Street to the institution, for physics and natural history laboratories, and a small increase of space for professor of metallurgy, would meet wants of School of Mines, 2472, 2473.

Were such laboratories not built, and some of the teaching removed, the School of Mines might still be retained in Jermyn Street, if additional house-room were provided for Geological Survey and Mining Record Offices, 2473, 2476.

Chemist and palæontologist essential officers in, 2473.

Is a public institution which will always serve its legitimate purpose, if not commingled with other public teachings, 2473.

The opinion of the Council of Professors of, as to removal of school, has not been taken officially 2480.

The College of Chemistry might be carried on in conjunction with the school, even if the college were removed to Kensington, as stated by Dr. Frankland, 2488.

It would be more convenient to have the College of Chemistry under the same roof as the School of Mines, but since the separation the School of Mines has gone on very well, 2488–2491.

*Samuelson, Mr.*

Allusion to Mr. Samuelson's committee, before which evidence was given respecting proposed removal of School of Mines, 2469, 2470, 2474, 2475, 2483–2485.

*South Kensington.*

Protest against removal of School of Mines to South Kensington, 2469–2473.

The School of Mines will always serve its legitimate purpose, if not commingled with other public teachings; but a great polytechnic school at South Kensington would be of importance in the scheme of national education, 2474.

Dr. Frankland's opinion cited, that if College of Chemistry were removed to South Kensington it could be carried on in conjunction with School of Mines as heretofore, 2488.

*Victoria.*

School of Mines now being established at Ballarat on the Jermyn Street plan, 2471.

BROUGH, LIONEL, Esq. (Index of his Evidence.)

*Accidents in Mines.* See *Mines.*

*Age of Mining Students.*

Those training for viewers go underground at 16 or 17 years of age, 2536.

*Apprentices to Viewers.* See *Miners.*

*Artizans.* See *Miners.*

*Assessment for Science Purposes.*

Approval of a fair tax on coal or wages to increase scientific education, 2619–2623, 2648–2650.

*Belgium.*

Mining engineers in, get high scientific education, but have less practical knowledge than those of Britain, 2599, 2628–2630.

BROUGH, LIONEL, Esq.—*Belgium*—cont.

More accidents, in proportion to coal worked, in Belgium than in Britain, 2631.

Natural mining difficulties in Belgium greater than in Britain, but there is less fire-damp, 2632–2635, 2638.

System of ventilation perfected in Belgium, &c. before England, 2639–2645.

*Bristol.*

Not a great centre as regards mining operations, 2618.

*Bristol Mining School.*

In south-western mining district there are managers who have been educated in Bristol mining school, but none from Royal School of Mines, 2498, 2525.

Excellent sub-officers produced from, 2498, 2499.

No Government stipend for, now; the school rendered good service, but was discontinued for want of funds, and embodied in the trade school, 2499–2505, 2507–2510, 2515, 2516, 2626, 2627.

There would have been a better attendance if the school had been situated in Wales; most of the boys were Welsh, 2510.

Plan of Royal School of Mines' classes followed by, 2515. The classes held in, now, bear no comparison to the mining classes formerly held, 2516, 2517.

The education given in, was not sufficiently high for managers, 2522.

None utterly ignorant came to the school; there were about a dozen real miners, 2559–2561.

Mining schools should be formed on the plan of, 2580. Fees, &c. at, 2581–2584.

Difficulty of carrying on such a school, 2617, 2618.

*Cardiff.*

A better locality than Bristol for a mining school, 2510.

*Coal and Collieries.* See *Mines.*

*Colliery Viewers.* See *Miners.*

*Contributions for Science Purposes.*

Withdrawn from Bristol and Glasgow mining school by colliery proprietors, 2502, 2507–2510, 2626, 2627.

Difficulty of supporting science schools by local contributions, 2617.

*Cost of Mining Schools.* See *Mining Schools.*

*Dowlais.*

Great amount of wages paid in; cost of a mining school would be an inappreciable per-centage on wages within the district, 2588–2591.

*Durham.*

Plan of mining education in connexion with the University, proposed by Mr. Nicholas Wood, 2506.

High education and large salaries of colliery viewers in Durham, 2544, 2647.

*Education of Miners.* See *Miners.*

*England.*

High education of viewers in north of England. Loss of life in mines less there than in Wales or Lancashire, 2544–2549.

Ventilation of mines was perfected on the continent before England, 2639–2645.

*Fees.*

Of students, in science schools; difficult to collect, 2626, 2627.

*Glasgow Mining School.*

Excellent men for sub-officers produced from, 2499.

Mining schools might be found on plan of, 2580.

The school dropped off from nonpayment of fees and withdrawal of contributions, 2626, 2627.

*Government.*

Stipend of, withdrawn from Bristol mining school, 2499–2504.

Could not be expected to support mining schools in all the kingdom, 2578.

Difficulty of supporting science schools, even when Government aid depends on continuance of contributions, 2617.

Government would be justified in making a fair tax on coal or wages for purpose of scientific education, 2619–2623, 2648–2650.

*Lancashire.*

Loss of life in mines less in north of England than in Lancashire; higher education of viewers in the north, 2544–2549.

*Managers, Viewers, &c. of Mines.* See *Miners.*

*Mathematics.*

A mining course should include mathematics, 2520, 2521, 2523.

Though not taught in School of Mines, useful men have come from there, 2524.



BROUGH, LIONEL, Esq.—cont.

**Merthyr.**

A better centre for a mining school than Bristol or Tredegar, 2510, 2568. It would accommodate a mining population of 200,000, 2567–2570.

Enormous amount of wages paid in; cost of a mining school an inappreciable per-centage on the wages, 2587–2591.

Salary of master for proposed school at, 2625.

**Metallurgists.**

In south-western mining district there are no metallurgists from School of Mines acting as managers, 2498.

**Miners (Managers and Workmen).**

No managers in south-western mining district who have been educated at School of Mines, 2498. Reasons assigned for this, 2525–2530.

Excellent men for sub-officers produced from mining schools of Bristol and Glasgow, 2498, 2499, 2502.

Many managers are well-educated men; many the reverse, 2506.

Better education wanted for our viewers; proposition of Mr. Nicholas Wood, 2506.

Many students went from Wales to Bristol mining school; schools would have been better in their own districts, 2510–2512.

Subjects desirable to be taught to young working miners, to enable them to become overmen, 2517–2519.

Higher subjects necessary to be taught to viewers, 2517, 2520–2524. They should undergo their curriculum first, and then work underground, 2531, 2538.

The viewer class are educated as such; occasionally overmen become viewers, 2532, 2533. Those training for viewers go at 16 or 17 into the pit, and never after are able to have a university education, 2534–2536, 2610–2613. They are usually ignorant of the sciences bearing upon mining, 2537. Attendance at a school of science during apprenticeship would be desirable; previous collegiate education better, 2614–2616.

A higher scientific education essential for economical working of mines and safety of life, 2539, 2545–2547. Northumberland and Durham said to possess the best educated viewers, 2544.

Were viewers scientific men, they would like their under-officers to possess a knowledge of science, 2549–2551.

Viewers not favourable to mining schools, 2553. Proprietors, &c. see necessity for science, 2554, 2555.

Recklessness of miners would be checked by advanced education, 2556, 2557.

None utterly ignorant came to Bristol school; about a dozen students were real miners, 2559–2561.

A mining population of 200,000 would be accommodated by a mining school at Merthyr, 2567–2570.

Overmen should be educated in schools of the grade of those at Bristol and Glasgow, 2579, 2580.

Education for viewers only to be got in universities, 2581.

Vast amount of wages paid to, in Wales, 2587–2590.

In witness's district, workmen would be glad of instruction in science, and are sufficiently numerous to constitute classes, 2594, 2595.

High scientific education of Belgian mining engineers, but they have less practical knowledge than those of Britain, 2599, 2630.

National loss of coal in Staffordshire, which might have been avoided if viewers had been better educated, 2600–2602.

Surveying conducted by miners with reference to the magnetic instead of the true north, 2606–2609.

Wages of men might be taxed to increase education, 2620–2622, 2648–2650.

Instances of good results shown by viewers of scientific education, 2636, 2637.

Educated viewers are sometimes passed over by lessees on the score of economy, 2646.

Viewers get high salaries, especially in Northumberland and Durham, 2647.

**Mines.**

Witness is inspector of coal and ironstone mines in south-western Britain, 2494–2497. No managers of mines in this district from Royal School of Mines, 2498, 2525–2530.

Essential subjects of education for managers and workmen of mines, 2506, 2517–2524.

Proprietors of collieries withdrew subscriptions from Bristol and Glasgow mining schools, 2499, 2502, 2507–2510, 2626, 2627.

Scientific knowledge especially essential for managers of fiery collieries, 2524, 2526, 2603–2605.

BROUGH, LIONEL, Esq.—*Mines*—cont.

Greater economy in working mines, and safety of life, would result from higher scientific education, 2539, 2545, 2546.

Instances of colliery proprietors possessing scientific attainments, 2540.

Loss of life, in proportion to quantity of coal, less in the north than in Wales or Lancashire, 2546; more lost by fall of materials than fire-damp, 2547.

Necessity for scientific knowledge seen by proprietors of mines, 2554, 2555.

Owners of mines in Wales and Monmouthshire have spoken of establishing a mining school, but it has not been taken up, 2576, 2577.

In economy of working, in mines, the cost of a mining school would be repaid, 2592.

The future deep working of mines will involve high scientific attainment as to ventilation, &c., 2596–2599.

National loss of coal in Staffordshire, which scientific knowledge might have prevented, 2600–2602.

Explosions in mines might be lessened by more knowledge of science, 2603–2605.

Danger of surveying mines with reference to the magnetic and not the true north, 2606–2609.

Scientific education of the highest importance in mining, 2613.

A tax might be made upon produce of mines, &c. to extend scientific education, 2619–2623.

More accidents, in proportion to coal worked, in Belgian, than in British mines, 2631. Natural difficulties greater in Belgian than in British mines. Less fire-damp, 2632–2635, 2638.

Ventilation system perfected in Belgium, &c. before Britain, 2636–2645.

**Mining Proprietors, Lessees, &c.**

Subscriptions of, withdrawn from Bristol and Glasgow mining schools, 2499–2505, 2507–2510, 2626, 2627.

Would not employ a viewer who had not been practically educated underground, 2530.

Instances of scientific knowledge possessed by lessees of collieries, 2540.

Necessity felt by, for more scientific teaching, 2554, 2555.

A science school for Wales and Monmouthshire has been spoken of by owners, &c., but not taken up, 2576, 2577.

Waste and accidents might be lessened if lessees were better educated in science, 2602, 2605.

Approval of a tax on, for increasing scientific education, 2619–2623, 2648–2650.

Economy of, sometimes militates against appointment of scientific viewers, 2646.

**Mining Schools.**

Those of Bristol and Glasgow have produced excellent sub-officers, 2499. The schools dropped off, from non-payment of fees, and withdrawal of contributions, 2626, 2627.

Want of one in Wales, 2510–2512.

None now in south-western mining district, 2514.

Subjects desirable to be taught in, for viewers and workmen, 2517–2524.

Viewers not favourable to mining schools, 2553. Proprietors, &c. of mines see necessity for scientific teaching, 2554, 2555.

One at Merthyr would accommodate the mining population of Wales, 2567–2570.

A school for Wales and Monmouthshire centre has often been suggested, 2576, 2577.

The more schools like Royal School of Mines the better; but, to educate overmen, Bristol and Glasgow schools might form models, 2578–2580.

No difficulty in getting teachers for secondary schools, 2581.

Teachers of, should be well paid, to ensure good men, 2585.

Cost of mining schools would be an inappreciable percentage on amount of wages paid in a district, 2585–2591, 2618. The education would repay the cost, 2592, 2593.

In witness's district, men would be glad to get instruction at, 2594.

Desirable if attendance at a school of science were a necessary part of training of a viewer's apprentice; previous collegiate education better, 2614–2616.

Difficulty of supporting local mining schools, 2617, 2618.

A tax upon coal or wages desirable, to increase education, 2619–2623, 2648–2650.

A teacher of a large school ought to receive 250*l.* or 300*l.* per annum, 2624, 2625.

Difficulty of getting the fees for, 2626, 2627.



BROUGH, LIONEL, Esq.—cont.

*Monmouthshire.*

Mining school for Wales and Monmouthshire suggested, but not carried out, 2576, 2577.

*Newport.*

A better locality than Bristol for a mining school, 2510.

*Northumberland.*

High education and large salaries of colliery viewers in, 2544, 2647.

*Practical Instruction.*

Colliery viewers must have been practically brought up underground, 2530.

Practical knowledge of Belgian mining engineers inferior to that of British miners, 2630.

*Royal School of Mines.*

In south-western mining district, there are no managers of mines or metallurgical works who have been educated at School of Mines, 2498. The students have sought employment abroad; or not have been practical workers in collieries, which would prevent them from becoming viewers, 2525–2530.

Classes of, most appropriate for teaching; the Bristol school endeavoured to follow the plan, 2515.

Though mathematics is not taught in, useful men have come from the school, 2524.

The more schools there are like the School of Mines the better, 2578, 2579. One generation could hardly tell the value that has resulted from it, 2592.

*Science (generally).*

It should be taught; not acquired by excessive study by young people after the labour of the day, 2540.

Improved state of scientific education in Staffordshire, 2543.

*Science Classes and Schools.* See *Mining Schools.*

*Science Teachers.*

No difficulty in getting teachers for secondary schools, 2581.

Teachers of mining schools must be well paid, to ensure good men, 2585.

*Staffordshire.*

Improvement of scientific education in, 2543.

Great national loss of coal there, which might have been avoided by scientific knowledge, 2600–2602.

*Surveying.* See *Mines.*

*Swansea.*

A better locality than Bristol for a mining school, 2510.

*Tredegar.*

Great mining centre of south-west district, 2564.

A mining school at Merthyr would accommodate Tredegar, 2568.

*Ventilation of Mines.*

The future deep working of coal mines will involve high scientific attainment as regards ventilation, &c., 2597–2599.

System of ventilation perfected in Belgium, &c. before Britain, 2636–2645.

*Wages.*

Cost of science school would be an inappreciable percentage on wages in such a district as Merthyr, 2586–2591.

A tax on miners' wages might be made, to extend scientific education, 2619–2623, 2648–2650.

*Wales.*

A mining school located in Wales would have had more support than that at Bristol, 2510.

Loss of life in mines, in proportion to amount of coal, less in north of England than in Wales, 2546.

The mining population of Wales would be accommodated by a mining school at Merthyr, 2567–2570.

A school for Wales and Monmouthshire centre has often been suggested, but not carried into effect, 2576, 2577.

Great amount of wages paid in Wales; to which cost of mining schools would be an inappreciable percentage, 2587–2590.

Belgian mines less fiery than those of Wales, 2638.

*Wood, Mr. Nicholas.*

Plan of education for colliery viewers proposed by, 2506.

THOMSON, THOMAS, Esq., M.D., F.R.S. (Index of his Evidence.)

*Age of Science Students.*

Many of the rejected Department candidates in botany, probably young children. Exceptional case, of a girl of eight, who passed in the elementary stage, 4896.

THOMSON, THOMAS, Esq.—cont.

*Botany.*

Witness was formerly in charge of Botanic Garden at Calcutta; and has acted as Department examiner in vegetable physiology and systematic botany for seven or eight years, 4880, 4881.

Sound knowledge of botany shown by a fair proportion of candidates, and higher standard reached during the last few years. Last year an exception, on account of the change of system, 4883, 4884, 4906.

About 500 candidates offered themselves last year, 4886. Many teachers of botany are incompetent, having no practical knowledge, 4888–4893.

In the medical schools there are botanical lectureships, but there are no classes anywhere for training teachers of botany, 4895.

Ages of rejected candidates in botany probably less than those who have passed. One girl of eight passed in the elementary stage, 4896.

No other science can be so well taught to young children, 4897. Vegetable physiology is not adapted to children, 4898.

Examinations in systematic botany are conducted by means of living specimens, 4899–4901.

Teachers must have passed the first class of the advanced stage, 4904.

Remuneration for teaching botany is so small, that masters get their information from books, instead of studying it in places where it can be properly learned, 4907.

Formerly there was a special examination of teachers of botany. Witness prefers the old system, 4908–4918.

There has been a gradual improvement in the teaching of botany, but it might have been greater if the old system had been attended to, 4919.

It is illusory to teach botany, in evening winter classes, from books, and without specimens, 4921–4929. It should be taught in the fields, in the summer, 4930.

It would be well to confine botanical classes to the spring and summer months, 4931.

Vegetable physiology may be taught at any time, and no one should be allowed to study that subject until he had passed in systematic botany, 4931.

Systematic botany could not be properly taught, in winter, and without specimens, by schoolmasters engaged during the day in elementary teaching, 4932.

It is the first branch of natural science which can be taught with ease to children, and may be made most attractive, 4933, 4934, 4936.

Systematic botany should be taught first, and vegetable physiology later, 4935.

Allusion to Professor Huxley's opinion as to the high value of the study of botany, 4936.

Cramming is as easy to detect in botany as in other subjects; but there is no objection to botany on the ground of its being liable to cramming, 4937–4939.

A microscope is of great advantage in teaching botany, 4940, 4941.

There are about 30 or 40 teachers of elementary botany connected with the Department, 4944.

*Calcutta.*

Witness has had charge of Botanic Garden at Calcutta, 4880.

*Children.*

A girl of eight passed in the elementary stage in botany, 4896.

Botany can be taught better than any other branch of natural science to young children; but not vegetable physiology, 4897. It might be introduced with advantage into elementary schools, 4933, 4934, 4936.

*Cramming.*

Many of the candidates trust to cramming; but that practice varies under different teachers, 4888.

Most of the rejected have been probably prepared by cramming from books instead of being taught from living specimens, 4902, 4903, 4925.

Can be detected by an examiner in botany, &c. Remarkable instance of cramming investigated by the Department, where 30 or 40 papers were found to have been dictated and learned by rote, 4937, 4938.

No objection to botany on the ground of its being liable to cramming, 4939.

*Elementary Schools.*

Masters of, have neither time nor means of properly studying botany, 4907, 4932.

Botany might be taught with advantage to children in elementary schools, 4933, 4934.



## THOMSON, THOMAS, Esq.—cont.

*Herbarium.*

An herbarium would be an insufficient substitute for real practical teaching of botany, 4922.

*Huxley, Professor.*

Opinion of, quoted, as to the high value of botany as a means of mental cultivation, 4936.

*Medical Schools.*

In all the schools there are botanical lectureships, but not specially for training teachers of botany, 4895.

*Microscope.*

Except for the very elementary stage of systematic botany, a microscope is a requisite for every science teacher, 4940, 4941.

*Plants.*

Living plants are sent for description in systematic botany examinations, 4893, 4899–4902.

In vegetable physiology, plants were not used in the special examination of teachers formerly held, 4908, 4909.

An herbarium is an insufficient substitute for living specimens in practical teaching, 4922.

*Practical Instruction.*

Deficiency of teachers in practical knowledge of botany, 4888–4893. Specimens for teaching botany can always be got in the summer, 4897, 4930.

Department candidates appear generally not to have been taught from living specimens; by aid of which, and in the fields, botany should be taught, 4902, 4903, 4921–4931.

An herbarium is an insufficient substitute for real practical teaching from living specimens, 4922.

*Science and Art Department.*

Witness has acted under, as examiner in botany, for seven or eight years, 4881.

Considerable good effected by Department system, 4882–4884.

Witness's suggestion to Department, that no one should study vegetable physiology until he had passed in systematic botany, 4931, 4935.

Remarkable case of cramming investigated by Department, 4937.

There are about 30 or 40 teachers of botany connected with the Department, 4944.

*Science Classes.*

There are none in London or elsewhere for training teachers as instructors in botany, 4895.

*Science Examination Papers (generally).*

The written papers are the only means by which examiners come in contact with candidates, 4882.

The schools whence the papers come are not known to the examiner, 4894.

*Science Examination Papers (in Botany).*

A considerable amount of sound knowledge of botany shown by the papers of a fair proportion of candidates, 4883.

Many of the papers show cramming, but that practice varies under different teachers, 4888, 4903.

The writing and spelling of most rejected papers show the candidates to be probably young children, 4896.

Great difficulty in setting a paper in botany sufficiently comprehensive to test all students, 4916.

Remarkable instance of cramming discovered in 30 or 40 papers, 4937.

*Science Examinations (generally).*

The Department system has done considerable good, 4882.

The higher examinations can now only be passed by those who have succeeded in the lower; approval of this system, 4884, 4885.

There was formerly a special examination for teachers; now they have merely to pass the highest grade of the ordinary examinations, 4891, 4892, 4908.

*Science Examinations (in Botany).*

Much sound knowledge and improvement shown by Department candidates in botany during the last few years, 4883, 4884.

The change of system last year, that no one be allowed to pass the higher who has not passed the lower examination, prevents a definite opinion of the result being formed at present, 4884, 4885.

There were 500 candidates for the botany examinations last year, 4886.

No special examination now for teachers of botany, &c., 4891, 4892, 4908.

Living plants are sent for description in systematic botany examinations, 4893, 4899–4902.

THOMSON, THOS., Esq.—*Science Examinations, &c.*—cont.

A fair proportion of candidates show they have been taught from living specimens. Most of the rejected have probably been taught only from books, 4902, 4903.

In the special examination for teachers formerly held, they were examined with specimens for systematic botany, but not for vegetable physiology, 4908, 4909. The certificate was given formerly for botany separately, which included the two sections, vegetable physiology and systematic botany, 4912–4914.

Great difficulty at present in setting a paper for examinations sufficiently comprehensive to test all candidates, 4916.

Preference given to the old system of examination, 4917, 4918. Examinations have shown a gradual improvement in the teaching of botany, but it might have been more rapid if the old system had been attended to, 4919.

Witness' suggestion to Department, that students should pass in systematic botany before studying vegetable physiology, 4931.

*Science Examiners (generally).*

Difficulty of their forming an opinion of the Department system, through not coming in contact with pupils, or being able to ascertain their after career, or amount of information retained by them, 4882, 4887.

Approval of examiners' recent plan, that no one should pass the higher who had not passed the lower examination, 4884, 4885.

Examiners do not know the schools whence their papers come, 4894.

*Science Examiners (in Botany).*

The examiner has only the control of a general examination over the attainments of a teacher of botany. There is great difficulty in setting a paper to test these attainments, 4916.

An examiner can as easily detect cramming in botany as in other subjects, 4937.

*Science Students (generally).*

Examiners not coming in contact with students, except by their written papers, have no means of tracing their after career, 4882, 4887.

A student who has passed in the first class of the advanced stage may now become a teacher of the subject in which he passes, 4915, 4916.

*Science Students (of Botany).*

A fair proportion show a sound knowledge of botany, 4883. They have been improving year by year, 4884. There were about 500 candidates in botany last year, 4886.

Many of them trust to cramming; but that practice varies under different teachers, 4888.

Allusion to paper containing the age of passed candidates. Many of the rejected were probably young children. One girl of eight years of age passed in the elementary stage, 4896.

They are required to describe living botanical specimens, 4899–4902.

Most of the rejected have probably been taught from books instead of from living specimens, 4902, 4903.

There is great difficulty now in setting a paper to test all classes of candidates, 4916.

No means of knowing by whom the rejected candidates were taught, 4920.

Are probably taught from books instead of from living specimens, in the winter. Objections to this, 4921–4929.

Suggestion of witness to Department, that students should not study vegetable physiology until they had passed in systematic botany, 4931.

*Science Teachers (generally).*

Examiners are not acquainted with either teachers or pupils, 4887.

They are not separately examined now, but merely have to pass the highest grade of the ordinary examination in every subject they undertake to teach, 4891, 4892, 4904, 4905, 4908.

Every teacher should possess a microscope, 4940.

*Science Teachers (of Botany).*

Cases of cramming vary with the teachers, 4888.

Many undertake to teach botany without a competent practical knowledge, 4889, 4890.

Teachers have now merely to pass the highest grade of the ordinary examination in each subject they teach, and the examiner cannot test their qualifications, as he could under the old system, 4891, 4892, 4904, 4905.



**THOMSON, THOMAS, Esq.—*Science Teachers, &c.*—cont.**

- There are no classes in existence for training instructors in botany, 4895.
- Rejections are greatly due to the teacher not having been properly taught, 4903.
- Remuneration of teacher so small that there is no inducement to study botany where it could be properly taught; and teachers of elementary schools have neither time nor means of studying the subject, 4906, 4907.
- In the special examination of, formerly held, specimens were used for systematic botany, but not for vegetable physiology, 4908, 4909.
- In the former examinations they received a certificate for botany separately, including the two sections of vegetable physiology and systematic botany, 4912–4914.
- A student who has passed in the first class of the advanced stage may now become a teacher of botany, 4915, 4916.
- Value of a microscope to science teachers, 4940, 4941.
- There are about 30 or 40 teachers of botany connected with the Department, 4944.

**Summer.**

- Specimens for teaching botany can always be got in the summer, 4897. Pupils should be taught at that season, 4930.

**Vegetable Physiology.**

- Should not be taught to young children, 4898.
- Living specimens were not used in the examinations in vegetable physiology formerly held for teachers, 4908, 4909.
- Vegetable physiology and systematic botany were the two sections which teachers had to pass to gain a certificate in botany, 4912–4914.
- It may be taught at any season, 4931.

**Winter.**

- Botany students in the country are improperly taught, from books, and in the winter, 4921–4931.

**ISELIN, JOHN FREDERICK, Esq., M.A. (Index of his Evidence.)**

**Animal Physiology.**

- Should be taught in elementary schools, 5922.

**Apparatus for Science Purposes.**

- More laboratory apparatus required now than formerly for demonstrations in chemistry, 5906, 5907.
- For teaching experimental physics not so abundant as for teaching chemistry, 5908.
- Same amount of apparatus and demonstration not required in elementary schools as in adult classes, 5921.
- See also *Laboratory Apparatus*.

**Arithmetic.**

- More attention should be paid to, in elementary schools, 5922.
- No science can be studied without a knowledge of decimals, 5922.

**Art Schools.**

- Number of, personally inspected, 5923, 5924.

**Botany.**

- Classes for botany are mostly held in summer; lectures in winter, and out-of-door instruction in spring and summer; they are few and widely scattered, 5909–5911.
- Necessity for practical observation in teaching, 5921.

**Bristol Trade School.**

- Founded by Canon Moseley; divided into two branches, elementary and scientific; classes of instruction in the scientific branch; number of boys in; fees; grants from Department to; future career of boys from; regret that its example has not been followed, 5945–5951.

**Burnley.**

- Schoolmasters' classes for instruction in teaching of science held at, 5905.

**Chemistry.**

- More adequate apparatus for instruction in, to be found now than formerly, 5906, 5907.
- The demand for services of science teachers in chemistry would be more in certain districts, such as Liverpool, Bradford, and Huddersfield, 5941.
- Chemistry, both organic and inorganic, taught in Bristol Trade School, 5945.

26060.

**ISELIN, JOHN F., Esq.—cont.**

**Children.**

- Subjects most suitable for science instruction to, in elementary schools, 5922.
- Number of Boys in Bristol Trade School, and their classes, 5945.
- Interest manifested by children in science subjects; difficulty of bringing them up to Department's standard of examination, 5952.

**Construction, Machinery and Building.**

- Taught in Bristol Trade School, 5945.

**Cramming.**

- Tendency to cram, more or less, under the Department's present standard examination; the introduction of elementary instruction in science into elementary schools would diminish the practice, 5952.

**Decimals. See Arithmetic.**

**Elementary Schools.**

- Same amount of apparatus and demonstration not required in, as in adult classes, 5921.
- Subjects most fitting to be taught in:—Physical geography, animal physiology, elementary mathematics, including geometry, and the higher principles of arithmetic, 5922.
- Desirability of introducing elementary instruction in science into; it would diminish cramming, and prepare pupils for more serious study, 5952.

**Euclid.**

- Geometry cannot be taught in elementary schools while Euclid is a text-book in secondary schools, 5922.

**Evening Schools.**

- With very few exceptions science schools are held in the evening, 5903.

**Examinations.**

- Examinations made by witness are for the purpose of forming his opinion as inspector; examination proper is another duty, 5898–5901.
- Cursory examinations of schools by witness and Royal Engineer officers as supplementary to their duties as inspectors, 5928–5936.
- Difficulty of getting young children up to standard of examination of Department, 5952.

**Experimental Physics. See Physics.**

**Fees.**

- In Bristol Trade School, 5945.

**Fossils.**

- Instructors in geology seldom form collections for themselves; public collections superior to private ones, 5915, 5916.

**Geology.**

- Not well illustrated by specimens; number of classes in geology limited; the study of it, so far as it goes, very good, 5912–5914.
- Teachers of, seldom form private collections of specimens; public collections are superior to any private ones, 5915, 5916.

**Geometry.**

- Cannot be taught in elementary schools while Euclid is a text-book in secondary schools, 5922.
- Practical geometry taught in Bristol Trade School, 5945.

**Inspection of Schools.**

- Witness's duties, as inspector of science schools, are those of inspection wholly, as distinguished from examination, 5897–5899.
- Number of, in science and art, personally inspected and cursorily examined, 5923, 5924, 5928–5936.
- Regulations of Department as to, are generally complied with, 5925, 5926.
- Royal Engineer officers assist in, and in the cursory examinations pendant thereto, 5928–5936.

**Keighley.**

- Attempt at, to follow example of Bristol Trade School, 5945.

**Leeds.**

- Schoolmasters' classes for instruction in teaching of science held at, 5905.

**Machinery Construction. See Construction, Machinery and Building.**

**Manchester.**

- Schoolmasters' classes for instruction in teaching of science held at, 5905.

**Mathematics.**

- Elementary mathematics, i.e., geometry and the higher principles of arithmetic, should be taught in elementary schools, 5922.
- Taught in Bristol Trade School, 5945.



ISELIN, JOHN F., Esq.—cont.

*Mechanics, Theoretical and Applied.*

Taught in Bristol Trade School, 5945.

*National School Teachers.*

Have taken up science subjects to teach after regular school hours; good effects of the practice, 5952.

*Payments on Results.*

Are made only on reports of inspectors of Education Department; never on witness's reports, 5901.

System of, adopted at Bristol Trade School, with good effects, 5947, 5948.

*Physics.*

Some teachers capable of giving instruction in, have not sufficient apparatus, 5908.

The demand for teachers of science in experimental physics would be chiefly in certain districts, such as neighbourhoods of Liverpool, Bradford, and Huddersfield, 5941.

Taught in Bristol Trade School, 5945.

*Physical Geography.*

Should be taught in elementary schools, 5922.

*Practical Instruction.*

Advantage of, to teachers of chemistry, 5906, 5907. In botany, 5910, 5921. Deficiency of, in the teaching of geology, 5912.

Advantage of, to teachers generally, 5917.

Should be extended, especially to adult classes, 5918–5921.

*Royal Engineers.*

Officers of, assist in the inspection of science and art schools, and in the cursory examinations pendant thereto, 5928–5936.

*Science and Art Department.*

Witness's duties as inspector of schools for science instruction in connexion with the Department, 5897–5902.

Regulations of, in science and art schools, generally complied with, 5925, 5926.

Facilities afforded by, to science teachers in manufacturing districts, 5938.

Payments by, to Bristol Trade School, 5945.

*Science Classes.*

Schoolmasters' classes for instruction in teaching of science are held at Manchester, Leeds, and Burnley, 5905.

Classes for study of botany are few and widely scattered; are mostly held in summer, 5909–5911.

Classes in geology, as in botany, not numerous, 5913.

Same amount of apparatus and demonstration not required in elementary schools as in adult classes, 5921.

Witness's duties as inspector are confined entirely to science schools, 5898, 5899; which are chiefly held in the evening, and attached either to elementary schools, or mechanics' institutes or clubs, &c., 5903, 5904.

Number of, personally inspected, 5923, 5924.

Teachers of science in certain subjects, such as chemistry and experimental physics, would have to itinerate, because of the few classes requiring them, 5940–5945.

*Science Teachers.*

Classes to instruct teachers in the teaching of science are held at Manchester, Leeds, and Burnley, 5905.

Derived their knowledge from books up to within the last two years; since then the opportunities afforded in London for experimental manipulation have been of increasing benefit, 5917–5921.

Insufficient number of competent science teachers throughout the country; facilities afforded by Science and Art Department to, in manufacturing districts; special means necessary for training high-class teachers, 5937–5939.

Their sphere of action depends on the subjects taught, 5940–5944. Would probably have to itinerate, 5942–5945. Elementary teachers of science in elementary schools should not be compelled to itinerate, 5944.

See also *National School Teachers.*

*Science Teaching.*

Desirability of introducing elementary science teaching into elementary schools; it would diminish cramming, and prepare pupils for more serious study, 5952.

*Sheffield.*

Private trade school attempted at, without success, 5949.

*Trade Schools.* See *Bristol Trade School.*

*Training College.*

Necessary for training high-class science teachers, 5939.

*Worcester.*

Attempt at, to follow example of Bristol Trade School, 5945.

DONNELLY, CAPTAIN J. F. D., R.E. (Index of his Evidence.)

*Accommodation for Science Purposes.*

Want of proper, for teaching geology, at Jermyn Street, 6108, 6109.

Want of accommodation for practical laboratory instruction, 6478–6480.

*Age of Science Students.*

Table showing ages of candidates, number examined, number successful, and per-centage of successes, in May 1870, 6104. References thereto, 6460, 6471–6475.

*Apparatus for Science Purposes.*

Assistance given in shape of apparatus for chemical classes by Science and Art Department, 6104. Value of apparatus granted to schools applying for the special grant in aid of laboratory expenses, 6105–6107.

*Architectural Drawing.*

Twenty-seven classes teaching, in 1867, 6082.

Great efforts made by Science and Art Department to encourage, 6082.

*Art Teachers.*

In elementary schools, practice of Education Department as to payment of, 6089.

*Artizans.*

The rule restricting payments on results to the artizan class should not simply be erased, otherwise artizans would be altogether excluded from State aid. Desirability of abolishing class distinctions, with regard to payments to teachers of science to artizans; the line is hard to draw; all classes should be admitted; interpretation of rule 36, as to payments to teacher for students of industrial classes only, 6445–6456.

*Bristol Trade School.*

Fair course of science instruction organised in, 6476.

Few schools analogous to, 6477.

*Candidates, Science and Art Department.*

Table showing ages of, in May 1870, number examined, number successful, and per-centage of successes to numbers examined, 6104. Reference thereto, 6460, 6471–6475.

*Chemistry.*

Assistance rendered by Science and Art Department in shape of apparatus to chemical classes largely taken advantage of. List of schools applying for special grant in aid of laboratory expenses, 6104. Value of apparatus granted, 6105–6107.

*Children.*

Change in revised code as to payments in respect of children of labouring poor, 6445.

Secondary schools, where boys learn science, are very limited in number, 6476.

*Classes.*

Number of, for drawing (geometrical, mechanical, machine construction, and free-hand,) in connexion with Science and Art Department, 6082.

None existing in 1859 for teaching descriptive geometry, 6085.

Per-centage of success and failure in classes for teaching geometry, 6086–6088.

*Class Distinctions and Restrictions.*

Desirability of abolishing, with respect to grants for science instruction and payments on results; the line of "industrial classes" or "artizans" is difficult to draw. Interpretation of rule 36, as to payments to teacher for students of industrial classes only, 6445–6456.

*Collusion.*

In Ireland, between students and teachers, as to return by latter of fees paid for instruction; a few cases of such practice in England, 6433. Difficulty of preventing it, 6436. Collusion would be promoted by insisting on payment of fees, 6444.

*Cost of Science Instruction.*

Increase of science teaching involves increase of cost; modes of meeting it, 6445, 6452, 6469, 6470, 6480–6486.

*Cramming.*

The more efficient the teacher the more liable he is to cram, if he desires to do so; cases of really bad cramming often by the ablest men; can only be checked by the examiner of the pupils; under a proper system of examination payments on results would check the practice, 6099–6103.



DONNELLY, CAPT. J. F. D.—cont.

*Education Department.*

Practice of, with respect to payment of teachers of art in elementary schools, 6089.

Possibility of giving instruction in elementary science in schools subject to action of, 6457.

No payment to be made by, to pupils receiving payment from South Kensington, and *vice versa*, 6458, 6459.

It and Science and Art Department might act in closer connexion in examination of pupils, 6461–6467.

See also *Samuelson, Mr.*

*Elementary Classes or Schools.*

Payments for science instruction in elementary classes are as low as can be, compatible with encouraging science instruction to the artizan class, 6452.

All teachers of science in elementary schools should receive State payment, irrespective of class, 6445.

See also *Samuelson, Mr.*

*Euclid.*

Opinion of examiners, that knowledge of pure theoretical geometry of a more advanced kind than is found in Euclid is absolutely necessary, 6084.

*Evening Classes.*

Science instruction in, will always remain casual, 6482.

*Examinations.*

Subjects of examination of students limited; examination of pupils might be carried on in closer connexion by the Education Department and the Science and Art Department, 6141–6147.

No effective means at present existing for practical laboratory examinations; the Department could arrange for such, if not checked by the Treasury, 6478–6481.

Since the abolition of special examinations, as able teachers have obtained qualifications as before, 6099.

*Examination Papers.*

Report of examiners, that the conditions of, are often neglected, 6084.

*Examiners.*

The examiners of pupils only can check the practice of cramming, 6099, 6102.

Desirability of increasing sphere of action of, 6469–6470.

Reports of science examiners, for 1870, as to the state of science education, quoted, 6084, 6085.

*Fees.*

Payment of, by students in classes in connexion with Science and Art Department not absolutely conditional, but strongly urged, 6432, 6433.

Amount of, shown in Appendix to Science Report and Science Directory, 6433.

Collusion between students and teachers for return of fees paid for instruction, chiefly in Ireland, 6433.

Nonpayment of, in science classes a bad thing, but difficult absolutely to be prevented; fees are paid in established classes where local interest is taken in them; an absolute condition that no grant be made unless fees be paid could be easily evaded, but it is the only way to meet the difficulty, 6436–6442.

To insist upon payment of, would be to promote collusion, 6444.

By admitting all classes at a small fee the existing restriction of State aid to “artizans” only might be abolished, 6448, 6452.

*Free-hand Drawing.*

Errors of Professor Jenkin in statistics of, 6081, 6082.

Efforts made by Science and Art Department to encourage, 6082.

*Geology.*

Teaching of, should be removed to South Kensington.

No appliances at Jermyn Street for proper instruction in. Geology and physical geography should be taught by same professor, 6108, 6109.

A teaching collection of specimens exists at Jermyn Street, independent of the museum, 6110, 6111.

*Geometry.*

Fifty-two classes teaching, in 1867, 6082. Great efforts made in Science and Art Department to encourage instruction in, 6082.

Reports of examiners for 1870, on state of education in, quoted, 6083, 6084.

Opinion of examiners that knowledge of pure theoretical geometry of a more advanced kind than is taught in Euclid is absolutely necessary, 6084.

No classes existing in 1859 for teaching descriptive geometry, 6085.

Per-centage of success and failure in classes for teaching geometry, 6086–6088.

DONNELLY, CAPT. J. F. D.—cont.

*Government Grants in aid of Science.*

To evening schools are restricted to adults; private adventure schools would take great advantage of, 6451.

Payments on account of elementary science instruction cannot be reduced without checking its increase, 6452.

Payments of fees by students in classes in connexion with Science and Art Department no absolute condition for, but strongly urged, 6432, 6433.

Propositions—with regard to State aid to science schools, as applied to payments on results to artizans—with regard to teachers of science in elementary schools—and with regard to *bond fide* local public institutions, 6445–6448.

*Inspectors.*

Those who have not received scientific instruction are of little use with regard to laboratory instruction. Technical inspectors necessary to meet technical work, 6468. Such work done by the present inspectors satisfactorily performed, 6469.

*Jenkin, Professor Fleeming.*

Errors stated by, in statistics of geometrical, mechanical, and free-hand drawing, 6081, 6082.

Erroneous opinion of, as to higher scientific instruction, 6089.

*Laboratories.*

List of schools applying for special grant in aid of laboratory expenses from Science and Art Department, 6104. Value of apparatus granted, 6105–6107.

Defective scientific teaching existing for want of practical laboratory instruction; ineffective means at present of examining; Department might arrange for practical examinations, if not checked by the Treasury, 6478–6480.

See also *Inspectors.*

*Local School Boards and Committees.*

Powers and utility of local authorities in dealing with science classes and schools, 6436–6442.

*Lord President.* See *Science and Art Department.*

*Mechanical Drawing.*

Professor Fleeming Jenkin's errors as to statistics relating to, 6081, 6082.

Forty-three classes teaching, in 1867; 2,000*l.* paid on the science side for, in same year, 6082.

Great efforts made by Science and Art Department to encourage, 6082.

Reports of examiners for 1870 on state of education in, 6083, 6084.

*Mining and Metallurgy.*

Might continue to be taught at School of Mines, 6108.

*Museum of Practical Geology.*

Has no accommodation for proper instruction of a large class in physical geography and geology, 6108.

Possesses a set of specimens for lecture purposes, independent of the museum collection, 6110, 6111.

*Payments on Results.*

Errors of Professor Jenkin in statistics relating to, 6082.

Misconception of Mr. Samuelson as to payment “simply” by Education Department on results of teaching science, 6089–6098.

Returns of, show that as able teachers have obtained qualifications since the special examinations were done away with as before, 6099.

Under a proper system of examination payments on results would check the practice of cramming, 6103.

Change in revised code as to payments in respect of children of labouring poor. The restriction on payments on results in favour of the artizan class should not simply be removed, otherwise artizans would be excluded from State aid altogether; all classes should be admitted, subject to certain restrictions 6445.

If laboratory work be demanded in connexion with technical instructors and examiners would be requisite, 6468. But if this be carried out to great extent, the cost of administration would much exceed the payments on results, 6469–6471.

No regulation existing by which payments on results are made in respect of laboratory instruction, 6478.

*Per-centage.*

Of success and failure in classes for teaching geometry, 6086–6088.

Of successes to numbers examined of candidates in May 1870, 6104.



DONNELLY, CAPT. J. F. D.—cont.

*Physical Geography and Geology.*

No accommodation at Jermyn Street for teaching a large class at; the class should go to South Kensington; might be taught by same professor, 6108, 6109.

*Plymouth.*

Action of local committee at, on appealing to Department, 6442.

*Practical Examination.*

A short *riid* race one in chemistry might be arranged by Lord President, 6480.

No effective means existing for practical laboratory examinations, 6478–6481.

*Private Adventure Schools.*

Should be excluded from all State aid to science, except with regard to the artizan class, 6447, 6448.

The establishment of, cannot be prohibited, 6449.

Would take advantage of Government grants for science instruction, 6451.

*Revised Code.*

Change by, of clause as to payments made for children of labouring poor, 6445.

Payments to students under, should be by Education Department or Science and Art Department, but not by both, 6458, 6459.

Limitation of subjects under, in which students may be presented, 6461.

*Samuelson, Mr.*

His misconception as to proposition for Education Department “simply” to pay for results in teaching, 6089–6098.

*Scholarships.*

Science instruction in secondary schools already to some extent encouraged by elementary schools’ scholarships and Science and Art scholarships, which are working well, 6486, 6487.

*Schools.*

List of schools applying to Science and Art Department for special grant in aid of laboratory expenses, 6104.

See also *Secondary Schools*.

*Science and Art Department.*

Table showing ages of candidates examined by, numbers examined, numbers successful, and per-centage of successes, in May 1870, 6104.

Assistance rendered by, in apparatus for laboratory expenses, largely taken advantage of, 6104–6107.

Payment of fees by students in classes in connexion with, no absolute condition, but strongly urged, 6432, 6433.

Students paid by, should not be paid also by Education Department, 6458, 6459.

Limitation of subjects under, in which students may be presented, 6461.

It and the Education Department might act in closer connexion in the examination of pupils, 6462–6467.

Has no existing regulation authorizing payments on results in examinations for laboratory instruction; the want attempted to be met by aiding laboratory instruction in chemistry; the Lord President and Vice-president could arrange for a short practical examination, if not checked by the Treasury; it would cost a great deal, 6178–6481.

*Science Classes.*

Payment by students of fees in, in connexion with Science and Art Department, not absolutely conditional, but strongly urged, 6432, 6433.

Proportion of local contributions of, not known, 6434.

Most successful where local efforts have been made; difficulty of preventing collusion in, between teachers and students, as to payment of fees; impossibility of refusing to recognise a second committee where one already exists, 6436–6440.

Establishment of rival schools or classes cannot be hindered, 6438, 6439.

Possibility of having advanced classes, in addition to elementary classes, 6457.

*Science Examiners.* See *Examiners*.

*Science Directory.*

If the present system of aid under, be opened to all, the artizan class would probably be excluded from State aid altogether, and private adventure schools will take large advantage of it, 6445.

Interpretation of Rule 36, as to payments made to qualified teachers for instruction of students of industrial classes only, 6456.

DONNELLY, CAPT. J. F. D.—cont.

*Science Instruction.*

Erroneous opinion of Professor Jenkin as to; method proposed by Department for promoting, 6089.

Payments for elementary science instruction cannot be reduced without checking its increase, 6452.

Possibility of having more advanced instruction in science, either in advanced classes or in secondary schools, 6457.

Under Science and Art Department, might be improved, by being more systematized, but secondary schools where boys learn science are very limited in number. Most of the frequenters are adults, 6476.

With regard to evening classes, will always remain casual; but in secondary schools might be on a definite and systematic plan, 6482–6486.

*Science Students.*

Report of examiners for 1870, as to deficiencies of, in geometry, 6084, 6085.

Ages of successful, and their per-centage, 6460, 6471–6475.

*Science Teachers.*

Opinion of science examiners that teachers are generally inefficient from want of a more extended knowledge in geometry than can be obtained from Euclid, 6084, 6085.

The more efficient the more able to cram; an able man has more capacity for cramming, in being able to judge of specialties of examiner, 6100–6102.

*Secondary Schools.*

Desirability of organising a system of science instruction in, 6476.

Science instruction in, might be arranged on a systematic plan, being already encouraged by elementary schools’ scholarships and by Science and Art scholarships, 6482–6486.

*South Kensington.*

Desirability of, as the locality for teaching physical geography and geology, 6108–6111.

*Special Examinations.* See *Examinations*.

*State Aid to Science Schools.* See *Government Grants in aid of Science*.

*Statistics.*

Errors in, in evidence given, noticed, 6080. Errors of Professor Jenkin as to statistics of geometrical, mechanical, and free-hand drawing, 6081, 6082.

*Teachers of Art.* See *Art Teachers*.

*Teachers of Science.* See *Science Teachers*.

SALES, HENRY H., Esq. (Index of his Evidence.)

*Age of Science Students.*

Yorkshire Board of Education has reference to students over 12 years, 6113.

Instruction in physical science given to children at 10 years in Yorkshire, 6123–6125, 6196–6198.

*Apparatus for Science Purposes.*

Deficiency of apparatus for science classes formerly; payment withheld now for imperfect apparatus, 6129, 6131–6134.

*Artizans.*

Desire for instruction by; success of lectures in science given at Leeds, 6144.

Do not attend museums because there is no one to explain them, 6218.

*Chemists.*

Students in Leeds Mechanics’ Institute mostly chemists and druggists’ apprentices, 6136, 6137.

*Children.*

Instruction of, in physical science, in primary schools, 6123–6125, 6196–6198.

*College of Science.* See *Training Colleges*.

*Contributions for Science Purposes.*

Aid given by employers in Yorkshire to mechanics, institutions, 6145–6147.

*Cramming.*

Department system has led to cramming; which properly organized schools might obviate, 6129, 6190, 6194.

Physical geography a subject for, 6196.

*Durham.*

Extension of University system to science subjects, 6207.

*Dyeing.*

Many students of Leeds Mechanics’ Institute are connected with dyeing, 6138.



SALES, HENRY H., Esq.—cont.

*Education Act.*

Will correct the evils brought about by Revised Code, 6225, 6226.

*Elementary Education.*

For adults; examinations were held last year at 26 centres in Yorkshire, and certificates and prizes awarded, 6117.

*Elementary Schools.*

Instruction of children in science in, 6123.

Desirable that Science and Art Department add a lower standard of examination applicable to, 6150-6153.

Might be taken, with science schools, in one graduated system of inspection, 6178-6182.

*Endowed Schools' Commission.*

Would allow exhibitions to be held in proposed Yorkshire college of science, 6149.

*Evening Classes.*

All classes are held in the evening in Yorkshire mechanics' institutes, 6119.

*Examinations.*

With reference to primary education for adults, examinations were held last year at 26 centres in Yorkshire, 6117.

See *Science Examinations*.

*Exhibitions.*

To be held at proposed Yorkshire college of science, 6149.

*Fees.*

Paid by students in Yorkshire mechanics' institutes, 6141.

In proposed Yorkshire college of science, 6148.

Paid at schoolmasters' science classes at Leeds, 6154.

*Field Clubs.*

Have lately arisen in Yorkshire, in connexion with mechanics' institutes, 6144.

*Government Grants in aid of Science.*

No State assistance given to Yorkshire Union or Yorkshire Board of Education, 6120, 6121.

Withheld where class is deficient in apparatus, 6131.

Grant has sometimes defrayed expenses and remuneration of teacher, 6141-6143.

Proposed Yorkshire college of science to be carried out without aid from Science and Art Department, 6168.

Not much public money, but more liberal treatment, necessary for establishing local training colleges, 6214.

*Hull.*

Science classes at Hull in connexion with Young People's Institute, 6122.

*Inspection.*

Objection to Department system of, 6173-6182.

Science inspectors should be qualified by professional training, 6177.

Elementary and science schools might be taken in one graduated system of inspection, 6178-6182.

*Keighley.*

Establishment of the trade school at, 6127.

Mechanics' Institute at, entirely due to manufacturers, 6147.

*Laboratories.*

Mechanics' institutes in Yorkshire which afford laboratory instruction, 6136-6140.

Intention of training colleges to establish, 6221, 6222.

*Lectures.*

Science lectures for artisans at Leeds, 6144.

*Leeds.*

Science lectures at, to working men, 6144.

Excellent museum at, 6216.

*London.*

Objection to a central science training college in London, 6202-6210, 6219.

*Manufacturers.*

Contribute to support of mechanics' institutes and science in Yorkshire, 6145-6147.

Keighley institute entirely due to, 617.

Proposed science college for sons of, in Yorkshire, 6148.

*Mechanics' Institutes in Yorkshire.*

Under Yorkshire Union and Board of Education; inspection, examinations, &c., 6113-6118, 6122.

Classes in, held in the evening, 6119.

Certificated teachers employed in, 6120.

Laboratory instruction in, 6136-6140.

Lectures to working men at Leeds, 6144.

Field clubs arising in connexion with, 6144.

Contributions of employers in aid of, 6145-6147.

See *Science Classes*.

SALES, HENRY H., Esq.—cont.

*Method.*

Duty of a professor of method in a training college, 6211-6213.

Method department essential in a college, 6228-6230, 6234.

*Metropolitan College of Science (proposed).*

Country teachers should not be made to go to London for training; establishment of such a college would be a mistake, 6202-6210, 6219.

Not many pupil teachers, after apprenticeship, would be likely to enter such a college, 6231, 6232.

*Museums.*

Excellent museum at Leeds, 6216.

No mechanics' institutes in Yorkshire provided with; museums not valuable unless explained, 6216-6218.

*Payment on Results.*

Full amount not given where class is deficient in apparatus, 6131, 6132.

Science teachers in Yorkshire dependent upon, 6141-6143.

Present system of, unsatisfactory; should include results of attendance, 6170-6172.

*Physical Geography.*

Class on, for schoolmistresses, 6161, 6165.

A subject for cramming, 6196, 6198.

*Practical Instruction.*

Mechanics' institutes in Yorkshire which afford practical instruction, 6136-6140.

*Primary Schools.* See *Elementary Schools*.

*Pupil Teachers.* See *Teachers*.

*Revised Code.*

Prejudicial to elementary teaching, 6123.

Evils brought about by, will be corrected by Education Act, 6225, 6226.

*Schoolmasters and Schoolmistresses.*

Certificated teachers employed in mechanics' institutes of Yorkshire, 6120.

Science classes instituted for, in Yorkshire, not now continued, 6122, 6123, 6154, 6165.

*Science.*

Scientific education in Yorkshire (1867), 6122, 6123.

Botany, zoology, &c. beginning to be studied in Yorkshire, 6144.

Lectures on science to working men at Leeds, 6144.

Subjects of, in institutions, should be prescribed by authority, 6193.

Children of 10 capable of receiving instruction in physical science, 6123-6125, 6196-6198.

*Science and Art Department.*

Schools connected with, in Yorkshire (1867), 6122, 6123.

System of, leads to cramming, 6129.

Payment withheld by, where class is deficient in apparatus, 6131.

Yorkshire college of science to be carried out without grant from, 6149, 6166.

Desirable that a lower standard, with a lower remuneration, be added to examinations of, 6150-6153, 6183-6187.

System of payments on results unsatisfactory; should include results of attendance, 6170.

Objection to Department system of inspection, 6173-6182.

Objection to sudden raising of standard by, 6186-6188.

Department system is becoming very beneficial, 6189-6194.

Should specify subjects that must be taken, 6195.

By frequent changes, has lost the confidence of teachers, 6202.

Pupil-teachers (members of science classes) may be expected to pass examinations of, at end of apprenticeship, 6231.

*Science Classes.*

Formerly instituted in Yorkshire for certificated masters and mistresses of primary schools, 6122, 6123, 6154-6165.

Department system of, leads to cram, 6129.

Proposed college of science in Yorkshire for students who pass through Department classes, 6148.

Objection to system of inspecting; graduated inspection desirable, 6173-6182.



SALES, HENRY H., Esq.—cont.

*Science Examinations.*

Desirable that a lower standard, with a lower remuneration, be added to Department examinations, 6150–6153, 6183–6187.  
System of, becoming beneficial; subjects should be prescribed by Department, 6189–6195.

*Science Inspection. See Inspection.*

*Science Students.*

Classes formerly instituted for schoolmasters and schoolmistresses in Yorkshire, 6122, 6123, 6154–6165.  
Instruction to boys in Yorkshire from 10 years of age; they belong to class of skilled workmen, 6124–6128, 6196–6198.  
Tendency to cram by, 6129.  
Receiving practical instruction in Yorkshire mechanics' institutes, 6136–6140.  
Fees paid by, in science classes, 6141.  
Proposed college of science in Yorkshire for giving higher instruction to, 6148.  
Lower Department standard desirable for, 6150–6153, 6183–6187.  
Science subjects for adults should be prescribed by authority, 6193.  
Pupil-teachers, after apprenticeship, unlikely to enter a college of science, 6231, 6232.  
There should be science pupil-teachers, 6233.

*Science Teachers.*

Deficient apparatus for, formerly, 6129.  
Dependent upon payment for results, 6141–6143.  
Instruction of, scholarships for, &c., in proposed Yorkshire college of science, 6201.  
Department, by frequent changes, has lost confidence of teachers, 6202.  
Objection to a central training college for, in London, 6202–6210, 6219.  
Instruction in method essential for, 6211–6213, 6228–6230.  
Remuneration of, 6219, 6220.  
The best were educated under former system in training colleges, 6227.  
Science teachers should have authorized science pupil-teachers, 6233.

*Teachers.*

Pupil-teachers, after apprenticeship, would not be likely to enter proposed college of science in London, 6231, 6232.

See *Science Teachers*.

*Training Colleges.*

Establishment of laboratories in, 6221, 6222.  
Great number of students and improved curricula of study in, at present; best teachers now were formerly trained in, 6223–6227.  
Probable foundation of, in several populous centres, 6207.  
Instruction in method in, essential, 6211–6213, 6228–6230.  
Pupil-teachers, after apprenticeship, would not be likely to enter a London college of science, 6231, 6232.

*Yorkshire.*

Scientific education in, in 1837, 6122.  
Increase of study of natural history in, 6144.  
Feeling in, that the county does not receive science aid in proportion to taxes, 6145, 6166.  
Contributions of employers in, to mechanics' institutions, 6145–6147.  
Teachers in, should not have to go to London for instruction, 6203–6205.

*Yorkshire Board of Education and Union of Mechanics' Institutes.*

Object and mode of action of, 6113, 6199, 6200.  
130 institutions in the Union; inspection, examination, teachers, &c. of these, 6113–6120.  
Report to Union on scientific education in Yorkshire, 6122.  
No one connected with the management of, derives pecuniary benefit from Science and Art Department, 6189.

See *Mechanics' Institutes in Yorkshire*.

*Yorkshire College of Science (proposed).*

Attention to be paid to working men's lectures in, 6144.  
Object, scheme of instruction, fees, and estimate for building proposed college, 6148, 6201, 6206.  
Feeling of county for, not tested to any extent, 6166, 6167.  
Expected to be carried out without State aid, 6168, 6169.

MIALL, LOUIS C., Esq. (Index of his Evidence.)

*Artizans.*

Could not prepare for examination Professor Huxley's "Physiology" in a two years' course, 6264–6266.  
Science classes in Bradford not attended by, 6298–6300.  
Advantage if payment on results were not confined to artizans, 6311, 6312.

*Bradford.*

Witness is member and secretary of Philosophical Society in, 6236.  
Superiority of Philosophical Society students to those of Science and Art Department; no opportunity of comparing them, 6267, 6305, 6306.  
Science instruction in; Department system working not so well as in other parts, 6237–6241, 6288, 6289.  
Contributions for scientific instruction by Philosophical Society and Mechanics' Institute in, 6295.  
Dissatisfaction in, with Science and Art Department, 6296, 6297.  
Success of Philosophical Society's classes, 6301, 6302.

*Contributions for Science Purposes.*

Given by Philosophical Society and Mechanics' Institute in Bradford, 6295.  
Uncertain whether Bradford people would contribute in conjunction with Science and Art Department, 6296, 6297.

*Cramming.*

Pays better than practical teaching, 6251.

*Directory (Science and Art).*

Text-books recommended by, mostly excellent, 6249.

*Dyeing.*

Instruction in chemistry of dyeing to be given in Bradford science class, 6302.

*Examination.*

Advantage of a literary examination for science students, 6290–6293.

*Huxley, Professor.*

Book of, on physiology, could not be prepared for examination by artizans in a two years' course, 6264–6266.

*Industries.*

Department science classes can produce no effect upon, 6303.

*Keighley.*

Building for science teaching at; plans submitted to Department, 6268.  
Hesitation of committee to connect themselves with Department, 6275, 6276.

*Lecture Rooms.*

Desirable that they should be constructed with a sloping floor, 6268.

*Mechanics' Institute.*

Large annual sum to be given by, in Bradford, for science instruction, 6295.

*Payment on Results.*

If teachers looked only to, they would not give practical instruction, 6250, 6251, 6256.  
Should be increased where candidate pass practical examination, 6284.  
If not confined to artizans, teachers would benefit, 6311, 6312.

*Philosophical Society. See Bradford.*

*Physiology.*

Recent examination in; best man plucked, 6258–6262.  
Professor Huxley's book on, could not be prepared for examination, in a two years' course, by artizans, 6264–6266.

*Practical Instruction.*

Department system respecting, defective, 6241, 6244.  
Written examinations not a test of, 6244, 6252, 6253.  
Best teachers make a point of giving, 6245.  
Would not be given, if teachers looked only to payment, 6250, 6256.  
An essential feature in all the Bradford science classes, 6257.  
Payment on results should be increased for practical examinations, as involving more expense and trouble in preparing candidates, 6284, 6285.  
Practical examinations would result in fewer candidates and increased cost; which would be compensated if payments on results were general; many assistant examiners would be required, 6287, 6308–6317.



MIALL, LOUIS C., Esq.—cont.

*Science.*

Defects in present science system are,—training and qualification of teachers too low; imperfect teaching owing to want of practical examination; subjects taught should be prescribed, 6277–6287.

A connected system of elementary instruction might grow up side by side with existing regulations, 6294.

*Science and Art Department.*

Does not encourage practical teaching; subjects too extensive; questions too difficult, 6241–6243.

Text-books recommended by, mostly good; objections to some, 6249.

Incentive to cram under, 6250, 6251.

Objection of many science teachers to connexion with, 6256, 6257.

Small number of genuine students turned out by, in west riding of Yorkshire, 6267.

Desirable that Department should require a sloping floor for lecture-rooms, 6268.

Existing regulations of, should not be hastily superseded, 6294.

Doubtful if Bradford people would contribute to science in conjunction with, 6296, 6297.

No effect on industrial occupations can be produced by science classes of, 6303.

*Science Classes.*

In Bradford; practical instruction given in, 6237–6239, 6257, 6301, 6302.

Small number of genuine students turned out by Department classes in west riding of Yorkshire, 6267.

Department classes produce no effect on industrial occupations, 6303.

*Science Examinations.*

Department questions too difficult, 6243, 6318–6320.

No written examination is a practical test; *vis à voce* examination indispensable, 6244, 6252, 6253, 6258–6262, 6269–6274.

Imperfectly educated students and teachers often pass the examinations, 6247, 6248.

Practical Department examinations would exclude many teachers and students, unless payments on results were general; many assistant examiners would be required, 6254, 6255, 6287, 6308–6317.

Students prepared specially for, would get inferior instruction, 6263.

Payments should be increased (on account of extra expense incurred) for candidates who might pass practical examinations, 6281, 6284.

*Science Examiners.*

A large staff of assistant examiners would be necessary for conducting practical examinations, 6314–6317.

*Science Students.*

Department course too extensive for, 6242.

Imperfectly educated students often pass, 6247.

Practical instruction given to, in Bradford classes, 6257.

Case of best candidate of four, in physiology, being plucked, 6258, 6259.

Preparation of, solely for Department examination, would result in attainment of inferior instruction, 6263.

Small number of genuine students turned out by Department classes in west riding of Yorkshire, 6267.

Bradford Philosophical Society students contrasted with those of Science and Art Department, 6267, 6305, 6306.

More expense and trouble in giving practical instruction to, than preparing by books, 6284.

There would be fewer students at first if practical instruction and examination were introduced, 6287, 6308–6313.

Advantage of a literary examination for, 6290–6293.

*Science Teachers.*

Department course too extensive for, 6242, 6321.

The best make a great point of practical illustration; others are indifferent, 6245.

Imperfect teachers can obtain certificates, 6247, 6248.

If they looked simply to payment, teachers would not give practical instruction, 6250, 6251.

Practical Department examinations would exclude many, 6254, 6255.

Objections of many, to be connected with Department system, 6256, 6257.

Payment to, should be increased, for students who pass in practical examinations, 6284.

Present qualification for, too low, 6321.

*Text-books.*

Recommended by Science and Art Directory, mostly excellent, 6249.

MIALL, LOUIS C., Esq.—cont.

*Yorkshire (West Riding).*

Small number of genuine science students turned out by Department in, 6267.

COOMBER, THOMAS, Esq. (Index of his Evidence.)

*Accommodation for Science Purposes.*

Good rooms for drawing at Bristol Trade School, 6333.

*Age of Science Students.*

At Bristol Trade School, boys pass from elementary to science part at 12; before which age preparation for Department examinations cannot be commenced 6346, 6361, 6365–6368, 6371–6380, 6420.

*Apparatus for Science Purposes.*

Good in Bristol Trade School, 6331, 6332.

*Apprentices to Chemists, &c. See Chemistry.*

*Artizans.*

Payments on results confined to, in Bristol Trade School, 6381.

Pharmaceuticals' apprentices and assistants considered as artizans by Science and Art Department, 6382.

Removal of conditions respecting artizans would but little affect Bristol Trade School, 6383–6387.

*Bristol.*

All the young people engaged in managing mines in neighbourhood of, have been educated at Bristol Mining School, 6409–6411.

Local cultivation of science in, 6428.

Proposal to form a high science school in, which should include medicine, commerce, engineering, manufactures, and mining, 6428–6431a.

*Bristol Trade School.*

Witness has been head-master of, for 15 years; also science teacher, &c., 6324–6328.

Subjects taught in, 6329, 6413. Good apparatus; rooms well adapted for drawing, 6330–6333.

History of foundation, and connexion of affiliated mining school with, 6334, 6397–6401.

Attended by mining school students for chemistry and drawing, 6335, 6336.

Evening classes in, attended by an association of pharmacutists, 6337.

Students belong to manufacturing and mechanical trades; latter chiefly, 6338. After leaving, they continue their education in the evening school, 6339, 6340.

Examinations of, are conducted by Science and Art Department, 6341.

A scholarship awarded to, by Royal School of Mines, to foster study of mining; three students have taken it, 6342. Positions held by these students, 6343.

A favourable medium for gaining scholarships, 6344, 6345.

160 boys (between 10 and 17) in the school; 100 of these not learning science. Mostly leave at 15, as masters refuse apprentices beyond, 6346. Most boys pass into science school after examination, 6347, 6348. Those who have left the school have occupied good positions, 6349, 6401, 6412.

Teaching in, of high value as mental training, 6350. Desirable to teach practical chemistry to upper form of boys, 6351, 6352.

Five masters in the school, 6353. For practical instruction, a laboratory assistant would be wanted, 6354.

Fees and expense of day school, 6355, 6356.

To add laboratories to, though essential for teaching chemistry and physics, would entail great expense, 6357.

Addition to subjects of study in, not desirable, 6358. Present subjects studied by every pupil, 6359. Proposed attempt at instruction connected with trades 6360.

Boys under 12 in, do not work for Department examinations, 6361, 6365–6368. They are taught mathematics before 12 years, 6369, 6370.

Payments on results in, only obtained for artizan pupils; the school would be little affected by alteration of this condition, 6381–6387.

Similar technical school to, established at Keighley, 6388.

Success of Bristol school; attributable to hard work only, 6390–6397.

Difficulty of finding teachers for such a school, 6394.

Exhibitions under Department in, 6395.

Instruction in evening school controlled by Department syllabus, 6399.

Mining portion of school; income, teacher, lectures, &c., 6402–6407, 6413.



COOMBER, THOMAS, Esq.—*Bristol Trade School*—cont.

Managers of mines in neighbourhood of Bristol educated at the school, 6408–6411.  
Proposed study of practical mining for Bristol Trade School students, 6412.  
Some students reside in Bristol, others come from South Wales, 6414.  
Prospectuses of school handed in, 6431a.

*Chemistry.*

Lectureships in, in Bristol, held by witness, 6328.  
Practical instruction in, to chemists' apprentices, &c., in Bristol Trade School, 6330. Evening classes attended by an association of pharmacutists, 6337.  
Laboratories essential for teaching chemistry, 6351–6354, 6357.  
Some points of chemistry, &c., may be taught to boys under 12, but not sufficient for Department examinations, 6371, 6376–6378.  
Teachers of, should exhibit power to handle tools, &c., 6422–6424.

*Children.* See *Science Students*.

*Commerce.*

Proposal to include commerce, with mining, &c., in a high science school at Bristol, 6428–6431.

*Contributions for Science Purposes.*

Only 50*l.* a year subscribed for Bristol Trade School, 6356, 6392.  
Immense public spirit existing at Bristol, which might be evoked in this direction, 6131a.

*Cossham, Mr.*

Valuable support given by, to Bristol Trade School, 6400, 6401.

*Cost of Science Instruction.*

At Bristol Trade School, 6355–6357, 6402.

*Drawing.*

Artificer's drawing taught in Bristol Trade School, 6329, 6335.

*Economy.*

Effected by affiliation of mining school to trade school at Bristol, 6335.  
Would be effected by union of several science schools in one institution, 6428–6430a.

*Education.*

Advantage of continuing, in night classes, after leaving day school, 6340.

*Elementary Schools.* See *Schools*.

*Engineering.*

Proposal to include, with medicine, mining, &c., in a high science school at Bristol, 6428–6431a.

*Euclid.*

Text-book in geometry in Bristol Trade School, 6370.

*Evening Classes.* See *Science Classes*.

*Examinations.* See *Science Examinations*.

*Fees for Science Instruction.*

In Bristol Trade School. These would be but slightly affected by alteration of conditions respecting artizans, 6355, 6383.  
On withdrawal of Mr. Cossham from Bristol Trade School, fees were raised to present standard, 6401.  
Mining teacher in Bristol Trade School receives 30*l.* from fees, 6402.

*Geometry.*

Taught to boys under 12 in Bristol Trade School, 6370.

*Keighley.*

Establishment of technical school at, on plan of Bristol Trade School, 6388.

*Laboratories.*

Of the highest importance for teaching practical chemistry and experimental physics, 6351, 6357.

*Mackworth, Mr.*

Originator of Bristol Mining School, 6334, 6400, 6401.

*Manufactures.*

Proposal to include, with mining, medicine, &c., in a high science school in Bristol, 6428–6431a.

*Mathematics.*

Boys under 12 taught mathematics in Bristol Trade School, 6369, 6370.  
Want of mathematical teaching in Royal School of Mines, 6425

*Medicine.*

Proposal to include with engineering, commerce, &c., in one high science school at Bristol, 6428–6431a.

COOMBER, THOMAS, Esq.—cont.

*Mining.*

Scholarship awarded to Bristol Trade School by Royal School of Mines, to foster study of mining, 6342.  
Most managers of mines near Bristol have been educated at Bristol mining school, 6409–6411.  
Proposed study of practical mining for Bristol Trade School students, 6412.  
Proposal to include, with medicine, engineering, &c., in one high science school at Bristol, 6428–6431a.

*Mining Schools.*

Proposals for establishing in South Wales or Monmouthshire; with prospectus, 6415, 6416.  
Necessity for affiliating a mining school to some other institution, 6428.  
See *Bristol Trade School*.

*Morgans, Mr. William.*

Formerly sub-manager of Brendon Hill iron mines.  
Teacher of mining in Bristol Trade School, 6405.  
Practical instruction in mining and surveying proposed to be given by, to students, 6412.

*Moseley, Canon.*

Connexion of, with Bristol Trade School, 6397, 6431a.

*Museums.*

One of the best provincial museums is in Bristol; proposals for utilizing it, 6428.

*Payments by Results.*

Confined to artizans in Bristol Trade School, 6381–6387.  
As a qualification to earn payments on results, teachers of chemistry and physics should exhibit power to handle tools, &c., 6422–6424.

*Pharmacutists.*

An association of, attend evening classes at Bristol Trade School, 6337.  
Pharmacutists' apprentices and assistants considered as artizans by Science and Art Department, 6382.

*Physics.*

Laboratories essential for teaching experimental physics, 6351.  
Some physics may be taught to boys under 12, but not sufficient for Department examinations, 6371–6373.  
Teachers of physical science should exhibit power to handle tools, &c., 6422–6424.

*Practical Instruction.*

In Bristol Trade School, boys are employed in preparing experiments; some, who are chemists' apprentices, are instructed entirely in practical chemistry, 6330.  
Proposed practical instruction in chemistry, mining, engineering, &c. to be given in connexion with Bristol Trade School, 6360, 6412.  
Department teachers of chemistry and physics should exhibit power to handle tools, &c., 6422.

*Royal School of Mines.*

Witness studied science in, 6325.  
Scholarship awarded by, to Bristol Trade School, to foster study of mining, 6342.  
Desirable to add mathematical teaching. Professors' assistants wanted, to explain difficulties, and to accompany students to mines, chemical works, &c.  
Too long a vacation, 6425–6428.

*Scholarships.* See *Bristol Trade School*.

*School of Practical Mining.*

Proposed to be established in South Wales; prospectus of same, 6415, 6416.

*Schools, Elementary.*

Science not taught in, in witness's district; recent legislation has altered that, 6417–6419. Might be introduced with advantage, 6420, 6421.

*Science.*

Boys under 12 cannot work rigorously at science, though they may learn some points, 6346, 6361, 6365–6368, 6371–6380, 6420.  
Contemplated teaching of applied science in Bristol Trade School, 6359, 6360.  
Not taught in elementary schools in witness's district recent legislation has altered that, 6417–6419. Might be introduced with advantage into elementary schools, 6420, 6421.  
Mining and medical schools should be affiliated to some institution of general science, 6428.  
Local cultivation of science in Bristol, 6428.  
Proposal to found a high science school at Bristol, for teaching pure and applied science, and to include medicine, commerce, engineering, manufactures, and mining, 6428–6431a.



COOMBER, THOMAS—cont.

*Science and Art Department.*

Examinations at Bristol Trade School are conducted only by Department, 6341.

Boys under 12 not fitted to undergo examinations of Department, 6346, 6361, 6365–6368, 6371–6380, 6420.

Department recognizes pharmacutists' apprentices and assistants as artizans, 6382.

Test imposed by, on teachers of chemistry and physics, should demand that they exhibit power to handle tools, &c., 6422–6424.

*Science Classes.*

Witness has been connected with, in Bristol, for 11 years, 6327.

An association of pharmacutists attend the evening classes of Bristol Trade School, 6337. Many pupils who have left the day school also attend, 6340.

*Science Examinations.*

At Bristol Trade School, are conducted by Science and Art Department, 6341.

Boys under 12 not fitted to undergo, 6346, 6361, 6365–6368, 6371–6380, 6420.

Prize in second grade cannot be taken without passing first grade; approval of this system, 6363, 6364.

Do not show that ability to handle tools, &c., which is essential for teachers of chemistry and physics, 6422–6424.

*Science Instruction.*

Subjects of, in Bristol Trade School, 6329–6333.

Boys not fitted to undergo much, before 12 years of age, 6346, 6361, 6365–6368, 6371–6380, 6420.

High value of, as mental training, 6350.

*Science Students.*

Boys under 12 cannot work rigorously at science, 6346, 6361, 6365–6368, 6371–6380, 6420.

One month sufficient vacation for, 6425–6427.

See *Bristol Trade School*.

*Science Teachers.*

Difficulty of finding, for Bristol and Keighley schools, 6394.

Masters of elementary schools study, in evening classes at Bristol, to become science teachers, 6417.

If properly educated in training college, teachers might impart scientific instruction in elementary schools, 6420, 6421.

In chemistry and physical science, teachers should show power to handle tools, &c., 6422–6424.

*Technical Instruction.* See *Science*.

*Trades.*

Followed by Bristol Trade School students, 6338, 6339.

*Vacations.*

Too long in School of Mines; one month sufficient for students, 6425–6428.

*Wales.*

Most pupils in Bristol Trade School come from South Wales, 6408.

Proposal to establish a mining school in South Wales, 6415, 6416.

GREENWOOD, J. GOUGE, Esq. (Index of his Evidence.)

*Accommodation for Science Purposes.*

Demand for, led to Owens College extension movement 7265.

*Act of Parliament.*

Incorporation of Owens College granted by Act of last year, 7270, 7273.

*Age of Science Students.*

At Owens College, students range from 14 to 24 years of age and upwards, 7251, 7359.

*America.*

Multiplying degrees in, has lessened their value, 7351,

*Artizans.*

Manchester Working Men's College absorbed in Owens College evening classes, 7251.

Whitworth exhibitions held by artizan candidates for Whitworth scholarships, 7283.

One or two holders of Rumney artizan scholarship in Owens College; more may be expected, 7287.

Case of an artizan foregoing a Department exhibition, because he had to hold it in London or Dublin; objections to this plan, 7287, 7348–7350.

Desire in Manchester, &c. for increased scientific education for artizans, 7300.

See *Working Classes*.

26060.

GREENWOOD, J. GOUGE, Esq.—cont.

*Berlin University.*

Introduction of science in, 7255.

*Cambridge University.*

Introduction of science in, 7255.

*Chemistry.*

Rapid development of chemistry branch of Owens College, 7253.

*Contributions for Science Purposes.*

Amounts subscribed for Owens College, and for its extension, 7258, 7266. Half has been subscribed by a few individuals, 7298.

*Cost of Science Instruction.* See *Owens College*.

*Degrees.*

Multiplication of degrees in America and Germany has lessened their value, 7351.

In any university giving degrees, there should be competition between different educational institutions, 7357, 7358.

See *London University*. *Owens College*.

*Elementary Schoolmasters.*

Owens College a fortunate centre for instructing, 7338, 7344. Their instruction would be chiefly in evening classes, 7347.

See *Science Teachers*.

*Endowments for Science Purposes.* See *Owens College*.

*Evening Science Classes.*

Establishment and success of, at Owens College.

Working Men's College absorbed in them, 7251.

Five-sixths of the students are of the working class, including under this term warehousemen and clerks in offices, 7294.

*Fees.*

Fees at Owens College compared with those at University College, &c., 7258–7263.

*Göttingen.*

Introduction of science in University of, 7255.

*Germany.*

Introduction of science into the old universities of Germany, as well as in special schools, 7255.

Multiplying degrees in Germany has lessened their value, 7351.

*Government Grants in aid of Science.*

Applications for, from Owens College. Government control over college, in consideration of grant, a fair matter of negotiation, 7266–7269, 7271, 7272, 7276–7279.

Conditions under which State aid might be granted to Owens College, &c., 7269, 7308–7318.

*Heidelberg.*

Introduction of science in University of, 7255.

Lectures given in the classical seminarium at, by members of higher teachers' class to lower, 7296, 7328.

*Huxley, Professor.*

Valuable scheme of evening science instruction for Owens College proposed by, 7292.

*Laboratories.*

Cost of proposed laboratory for Owens College, 7267.

*Lancashire.*

Increased desire in, for scientific education of the industrial classes, 7300.

Larger number of Science and Art Department classes in, than in any similar area in England, 7339.

*Literature.*

Study of, should be combined with science, in one institution, 7254, 7319–7327, 7360, 7361.

*London University.*

Owens College studies adapted for degrees of, 7257.

More students go to, than to the old universities, 7342, 7343.

Approval of degrees being given by, to Owens College students, 7351, 7352. Might be made more public, if London University held an occasional session in Manchester, 7352, 7356.

*Magnus, Professor.*

Opinion of, quoted, as to science teaching and technical instruction, 7283.

*Manchester.*

Necessity for science being taught in, even more than in London, &c., 7253, 7254.

Meeting at, to forward Owens College extension, 7266. Desire in Manchester for increased scientific instruction for industrial classes, 7300.

Site in, for Owens College, 7301–7307.

Large amount of science teaching in Manchester district, 7338, 7339.

Advantage of its position for students, 7340, 7341.



GREENWOOD, J. GOUGE, Esq.—cont.

*Method.* See *Professor of Method.*

*Owens College.*

Witness is principal of, 7250.

Foundation, students, evening classes, &c., of, 7251, 7359.

Locality of, has had a marked influence on the education provided in, 7253.

Advantage of combination of literature and science studies in. Students select subjects of study, 7254-7257, 7319-7327.

Endowments, fees, &c. in, 7258-7263.

Application from College to Government, 7266-7269.

Growth of science department in; Owens College extension, 7264-7282, 7301-7307.

Conditions under which State aid might be granted to, 7269, 7308-7318.

Artizan students in, holders of Rumney scholarships; two-fifths of students are sons of Manchester warehousemen, &c.; many from surrounding districts, 7287-7291. Few go to old universities; most go to London University, 7342, 7343.

Case of artizan student in, who relinquished a Government exhibition because he was obliged to go to London or Dublin; objection to this system, 7287, 7348-7350.

Success of evening classes in the College; 527 attend; means of methodizing instruction incomplete, 7292-7294.

Valuable system of evening instruction in the College proposed by Professor Huxley, but funds insufficient to carry it out, 7292.

Payment on results by Department would not cover expenses of evening classes in, 7293.

A special class might be held in, for those likely to become teachers, 7295, 7296.

The College fund is considerable, and has been subscribed by a few individuals, 7298.

A professor of method in the College desirable, but he should be an assistant professor, 7331-7337.

Owens College a good centre for instruction of schoolmasters; positions of some so instructed, 7338-7341, 7344-7347.

Inexpedient for the College to grant degrees; the London University does the work effectually, but might hold a session in Manchester, 7351-7358.

*Oxford University.*

Introduction of science in, 7255.

*Professor of Method.*

Would be desirable in an institution, but he should be as an assistant, 7334-7337.

*Royal School of Mines.*

More than one such centre of the highest scientific teaching should be provided, 7629.

*Rumney Scholarships.* See *Scholarships.*

*Scholarships.*

Admirable scholarships founded by Mr. Rumney, for artizans; must be held now in Owens College, 7287.

Great impulse given to study of science by exhibitions of Sir J. Whitworth, 7283, 7285.

*Science.*

With literature, should be studied in one institution, 7254, 7319-7327, 7360, 7361.

Necessity for science in Manchester greater than in London, &c., 7254.

High value of science as culture and discipline, 7254.

Danger of the application of science becoming more regarded than science itself, 7254, 7283.

Higher scientific instruction not self-supporting, 7269.

Introduction of science into English and German universities, 7255.

Desire in Manchester district for increased scientific education of industrial classes, 7300.

See *Owens College.*

*Science and Art Department.*

Owens College would be glad to avail itself of the 25*l.* offered by, on condition of a like sum being raised, 7284-7286.

Case of an artizan who had to forego a Department exhibition because it was to be held in London or Dublin; objection to this plan, 7287, 7348-7350.

Larger number of Department classes in Lancashire than in any similar area in England, 7339.

*Science Students.*

Students of all classes derive benefit from the study of science, 7254.

See *Owens College.*

GREENWOOD, J. GOUGE, Esq.—cont.

*Science Teachers.*

Best training for, is under good professors; instruction in a normal college has advantages, but also defects, 7295.

Might be trained to method in Owens College, as at Heidelberg, 7295, 7296, 7328-7330.

Teachers might practise teaching in Manchester, if there were a gradation of schools there, 7331-7333.

A teacher of method desirable in an institution, but he should be an assistant, 7334-7337.

Owens College a fortunate centre for instructing teachers, 7338-7341, 7344-7347.

Positions held by science teachers trained in Owens College, 7345.

*Society of Arts.*

Definition of "technical training," in a paper of Society of Arts, 7283.

*Technical Instruction.*

Danger of science being sacrificed to technical instruction, 7283.

*Training Colleges.*

Teaching in normal colleges has advantages, but also defects, 7295.

*Whitworth Scholarships.* See *Scholarships.*

*Working Classes.*

Five-sixths attending Owens College evening instruction are of the working classes, including warehousemen and clerks in offices, 7294.

See *Artizans.*

*Working Men's College, Manchester.*

Absorbed into Owens College evening classes, 7251.

ROSCOE, HENRY ENFIELD, Esq., F.R.S. (Index of his Evidence.)

*Accommodation for Science Purposes.*

Inadequate chemical laboratory at Owens College; complete one provided in new building, as well as dissecting rooms, workshops, &c., 7369-7376.

Extensive laboratories and other buildings devoted to science at Berlin, Bonn, Leipzig, &c., 7384, 7385, 7389, 7390, 7406.

*Age of Science Students.*

For entrance in German universities, 18 years, 7389.

Artizan students in Owens College are 20 to 22 years of age, 7411.

*Artizans.*

Scientific principles must be taught to youths; through want of time and knowledge of principles, artizans are difficult to instruct, 7394.

Demand for science instruction by artizans; these make the best students, 7408.

Whitworth scholarships gained by, but not confined to, artizans, 7409, 7410.

In Owens College, artizan students are from 20 to 22 years of age, 7411.

Lectures, classes, &c. for artizans in Manchester, 7431.

*Arts.*

Objection to teaching arts or manufactures; sound principles of science the first essential, 7367.

*Berlin.*

Science instruction at, 7384, 7385, 7389, 7391.

*Bonn.*

Science instruction at, 7384, 7385, 7389, 7391.

*Brackenbury, Miss.*

Contribution by, for incorporating Manchester School of Medicine with Owens College, 7377.

*Calico-printing.* See *Lancashire.*

*Carlsruhe.*

Science instruction in, 7389.

*Chemistry.*

Fees for science course in Owens College; chemistry fees lower than in London, 7364, 7365.

Many Owens College chemistry students enter without any knowledge of the subject, 7366.

An assistant professor should be provided for every 20 students, 7389.

The greatest chemical discoveries in Germany have resulted from pure, not applied, science, 7390. The most important chemical schools have been in the universities, 7391.

Advantage of having intermediate instruction between Owens College chemistry classes and ordinary colour shops; but instruction difficult to devise, 7393-7401.

Instruction in chemistry, &c. should be directed by one professor, assisted by subordinate men, 7404.



**ROSCOE, HENRY E., Esq.—Chemistry—cont.**

Dalton scholarships for original research in chemistry at Owens College, 7412-7416, 7419, 7420.  
List of original investigations in chemistry, made in Owens' College laboratory, 7422.

**Colour Shops.**

Instruction wanted between Owens College chemistry classes and ordinary colour shops, 7393-7401.

**Continental Science Schools.** See *Science Schools (Continental)*.

**Contributions for Science Purposes.**

Donation of 10,000*l.* by Miss Brackenbury towards incorporation of Manchester School of Medicine with Owens College, 7377.

**Cost.**

Cost of new laboratories and other buildings at Owens College, 7369, 7377.

Cost, in Germany, of laboratory fees, and erecting and working laboratories; salaries of professors and assistants, and apparatus; buildings, &c., 7384, 7385, 7389, 7406.

Cost to Government of science colleges would be repaid in proper training of science teachers, 7435.

**Council of Scientific Advice.**

Desirability if forming, to assist Government; should not consist solely of men of science, 7436-7439.

**Dalton Scholarships.**

For original research in chemistry; not much competition for, at Owens College, 7412-7416, 7419, 7420.

**England.**

Compared with Germany, &c., as to science instruction, 7384-7387, 7403.

**Fees.**

For science courses at Owens College; chemistry course lower than in London, 7364, 7365.

For laboratory instruction, &c., in Germany; lower than in England, 7384, 7389.

**Freiberg.**

Mining academy at Freiberg, and connected Free Mining School at Zwickau, 7389.

**French Language.**

Necessity of studying, in connexion with science course, 7364.

**German Language.**

Should be studied, in connexion with science course, 7364.

**Germany.**

Science teaching in Germany compared with England; larger number of teachers; more effective instruction of students; fees lower; large sums spent on laboratories, &c., 7384-7387, 7389, 7402-7406.

Relation between German universities and polytechnic schools, and distinction between science instruction therein; relation of these to Government, 7389-7392.

Seminaria in, 7389.

The most important chemical schools of Germany have been in the universities, 7391.

Peculiar system of teaching in Germany; not entirely applicable to England, 7402, 7403.

Employment formerly of chemists from Germany in chemical works round Manchester, 7407.

German university system, rather than the polytechnic schools, a model for England, 7430.

**Giessen.**

School of chemistry in university of, 7391.

**Göttingen.**

Science instruction at, 7384, 7389.

**Government.**

Relation between Government and academical bodies in Germany, 7389, 7406.

Scholarships of, less desirable than those founded by private munificence, 7417.

Institutes providing physical laboratories have a claim on Government, 7418.

Government can best aid science by foundation of professorships, and by helping what is now going on, 7425-7429.

Cost to Government of science colleges would be repaid in proper training of science teachers, 7435.

A consultative science council desirable, to advise Government on matters of scientific instruction, 7436-7439.

**Government Grant Committee.** See *Royal Society*.

**Heidelberg.**

Science instruction at, 7384, 7389, 7391, 7402.

**Hofmann, Dr.**

Allusion to report of, on German laboratories, 7385.

**ROSCOE, HENRY E., Esq.—cont.**

**Huxley, Professor.**

Popular science lecture by, at Manchester, 7431.

Important proposition by, for systematizing evening science instruction in Owens College, 7431.

**Laboratory.**

Chemical laboratory at Owens College inadequate; new laboratories in progress; laboratory fees, &c., 7364-7376.

Cost of construction, working expenses, &c. of chemical laboratories of Berlin, Bonn, Leipzig, &c., 7384, 7385, 7389-7391, 7406.

Advantage of instruction between Owens College chemical laboratory and ordinary colour shops, 7393-7401.

Former employment of German chemists in English laboratories, 7407.

Many students from Owens College chemical laboratory now occupy positions of trust, 7407.

Dalton scholarships must be held one year in Owens College, and another in some other college, 7413.

Professor Balfour Stewart on physical laboratories, 7418.

List of original investigations made in Owens College laboratory, 7422.

**Lancashire.**

Calico-printers, &c. of Lancashire would benefit if instruction could be devised between Owens College chemistry classes and ordinary colour shops, 7393-7401.

Special need for high scientific instruction in Lancashire, 7407.

**Leipzig.**

Science instruction in, 7384, 7389, 7391.

**Lockyer, Mr. Norman.**

Popular science lecture by, at Manchester, 7431.

**London.**

Approval of bringing science teachers to London for instruction, 7433, 7434.

**London University.**

Special course of study in Owens College for London University degrees, 7364.

**Manchester.**

Royal School of Medicine in, to be attached to Owens College, 7376-7379.

Manchester is a centre where are carried on most important industries depending on science, 7407.

Positions of trust in Manchester Chemical Works filled by Owens College students; Germans formerly appointed to these posts, 7407.

Scientific instruction in Manchester; lectures by Professor Huxley, Mr. Norman Lockyer, &c., and science classes, 7431.

**Manufactures.**

Objection to teaching arts and manufactures; sound principles of science the first essential, 7367.

**Medical School.** See *Royal School of Medicine, Manchester*.

**Meteorology.**

Advantage of a physical laboratory in connexion with, 7418.

**Mining Schools.** See *Science Schools*.

**Munich.**

Science instruction in, 7389.

**Original Research.**

Teachers of science should pursue original research, 7421.

List of original chemical investigations made in Owens College laboratory, 7422.

Best way of promoting original research, 7425.

Foundation of high-class science schools would tend to increase original research, 7428.

**Owens College.**

Witness is professor of chemistry in, 7363.

Students and their subjects of study in Owens College; a distinct course for London University science degrees, 7364. Students in chemical laboratory, 1870-71, and chemistry classes since foundation, 7365, 7366. Positions of trust held by students, 7407.

Fees for science courses in the college; lower than in London; higher than in Germany, 7364, 7365, 7384.

Inadequate chemical laboratory accommodation in Owens College; new laboratory building; its size, cost, &c., 7369-7373. New buildings will accommodate natural philosophy, engineering, and natural history departments, with workshops and dissecting rooms for students, &c., 7373-7376, 7381, 7383.



ROSCOE, HENRY E., Esq.—Owens College—cont.

Manchester Royal School of Medicine proposed to be attached to Owens College, 7376-7379.

Report to Owens College Extension Committee on continental science schools, 7389.

Instruction desirable between Owens College chemistry classes and colour shops, but difficult to devise, 7393-7401.

Subdivision of professorships in Owens College, 7404, 7405.

Demand for science instruction in Owens College by artizans, 7408-7411.

Whitworth, Dalton, and Rumney scholarships in Owens College; additional scholarships desirable, but they should be founded by private munificence, 7409, 7410, 7412-7417, 7419, 7420.

List of original chemical investigations made in Owens College laboratory, 7422.

Systematization of scientific instruction in Owens College proposed by Professor Huxley, 7431.

#### Physics.

Instruction in physics should be directed by one professor, assisted by subordinates, 7404.

*Polytechnic Schools.* See *Germany*.

#### Practical Instruction.

In continental schools of science; comparison with those of England, 7384, 7389.

*Privat-docenten.* See *Science Teachers*.

*Professors.* See *Science Teachers*.

#### Professorships.

Foundation of professorships in science the best aid that could be rendered by Government, 7425-7429.

See *Science Teachers*.

*Répétiteurs.* See *Science Teachers*.

#### Report.

Of Dr. Hofmann and of M. Wurtz, on German laboratories, 7385.

To Owens College Extension Committee on continental science schools, 7389.

#### Royal College of Chemistry.

Fees for laboratory instruction in, compared with Owens College, 7364.

#### Royal School of Medicine, Manchester.

Contemplated attachment of, to Owens College; Miss Brackenbury's contribution for this purpose, 7376-7379.

#### Royal School of Mines.

Cost of instruction in, compared with Owens College, 7364, 7365.

#### Royal Society.

A body similar to Government Grant Committee of, is required, to furnish funds for physical purposes, 7418.

#### Rumney Scholarships.

In Owens College; remission of candidates' fees by professors, 7412.

*Scholarships.* See *Science*.

#### Science.

Special course in Owens College for London University degrees, 7364.

French and German should be studied in connexion with science, 7364.

Importance of foundation of sound scientific principles; application easy, 7367.

The higher scientific instruction can never be self-supporting, 7382.

England and the continent in respect to scientific instruction, 7384-7387, 7403.

Difficulty of instructing artizans in science, 7394.

Science scholarships in Owens College; more desirable, 7409-7417, 7419, 7420.

Little encouragement now to science; Government should found professorships, and high-class science schools, 7425-7430.

Science lectures, classes, &c., in Manchester, 7431.

Department science instruction in Lancashire still imperfect, 7432.

Desirability of a consultative science council, to advise Government, 7436-7439.

#### Science and Art Department.

Dr. Hofmann's report to, on chemical laboratories, 7385.

Department science instruction in Lancashire still imperfect, 7432.

Objection to Department system which allows a man to teach after passing one examination, 7435.

*Science Classes.* See *Science*.

ROSCOE, HENRY E., Esq.—cont.

#### Science Examinations.

Objection to Department system of, which allows a man to teach after passing one examination, 7435.

#### Science Schools (Continental).

Report on universities and high schools of science of Bonn, Göttingen, Berlin, Leipzig, Freiberg, Heidelberg, Carlsruhe, Munich, and Zurich, 7384-7389, 7402-7406.

See *Science*.

#### Science Students.

Effective instruction for, in continental schools, 7384-7389.

Difference between class of students attending universities and polytechnica of Germany, 7390.

See *Owens College*.

#### Science Teachers.

More professors and assistants in Germany than England; professors in universities are of three grades, professor ordinarius, professor extraordinarius, and privat-docens; advantage of these competing with each other, &c., 7384-7389, 7402, 7403, 7406.

Subdivision of professorships in Owens College, 7404.

Fees remitted by professors in Owens College for Rumney scholarship candidates, 7412.

Claim on Government of professors in physical laboratories, 7418.

Teachers of science should have leisure for original research; this can be effected if they are assisted by répétiteurs, 7421-7428.

Department teachers in Lancashire are ill-educated, 7432.

Objection to teachers who have passed but one examination; they should be trained in science colleges, 7435.

#### Seminaria.

In Germany; might be introduced here with benefit, 7389.

#### Stewart, Professor Balfour.

Physical laboratory under, in Owens College, 7366.

On physical laboratories, 7418.

#### Training Colleges.

Proper education in, of science teachers, will repay Government cost, 7435.

*Universities (Continental).* See *Science Schools (Continental)*.

#### Whitworth Scholarships.

Artizans who have gained them in Owens College; half are adjudged to artizans and half to students, 7409, 7410.

#### Wurtz, M.

His report on German laboratories, 7385.

#### Zurich.

Science instruction in, 7384, 7389.

#### Zwickau.

Account of Zwickau Free Mining School, 7389.

CROMWELL, REV. JOHN G., M.A. (Index of his Evidence.)

#### Age of Students.

Students at St. Mark's College are admitted at 16 years, 7904.

Physical geography can be well taught to boys of seven to 13 years, 7982.

#### Apparatus for Science Purposes.

At St. Mark's College, is chiefly for teaching mechanics, 7939-7942.

#### Children.

Many laws of nature can be taught to children, 7926.

Physical geography may be well taught to; also drawing and mensuration, 7982-7985.

Very elementary science instruction might be given to, 7985.

#### Drawing.

Can be usefully taught in elementary schools, 7985.

#### Education.

Fair general education essential as a preliminary to special instruction, 7921-7926.

General education more defective now than before passing of Revised Code, 7927, 7928.

See *Syllabus (Education Department)*.



CROMWELL, REV. J. G.—cont.

*Elementary Schools.*

Physical geography the best subject of instruction for, 7926, 7982-7984.

St. Mark's College students are training for teachers in elementary schools, the term now embracing higher schools, 7949.

Drawing and mensuration can be well taught in, 7985.  
Elementary science only might be taught in; not that required by Science and Art Department, 7985, 8030.

*English History.*

Objection to Government syllabus requirement for, 7950, 7951.

*Examinations.*

Objection to certain examinations of Education Department, 7950-7963.

Students who have passed a lower examination frequently recommended in preference to those who have passed a higher, 7962, 7963.

*Fees.*

In St. Mark's College model schools, are 15s. to 25s. per term, 7988-7990.

250*l.* a year in fees paid by St. Mark's College students, 7995.

*Government.*

Science lectures in training colleges formerly paid by, 7904-7906.

Might object to training colleges having some students who paid higher fees than the others, 7975.

Saint Mark's College receives about 4,000*l.* a year from, 7992.

A science college established by, would not have many teachers from training colleges, because they look for employment on leaving, 8015-8018.

See *Syllabus (Education Department)*.

*King's Somborne School.*

Excellent school for labourers' children, in which chemistry, mensuration, &c. were taught, 7931-7933.

*Laboratory.*

One at St. Mark's College, 7904, 7938-7940.

*Lectureships in Science.*

Founded in 1854; lecturers were instructed in training colleges, and paid by Government and college committees; all abolished, 7904-7906.

*Lodgings for Students.*

Objection to students living in lodgings; they should enter a training college, 7997-8004.

*London.*

Better to establish science schools in the provinces than to bring men to London, 8027, 8028.

*Mensuration.*

Desirable that mensuration should be taught in elementary schools, 7985.

*Metropolitan College of Science (proposed).*

Teachers from training colleges would not be likely to attend in large numbers; difficulties greater with respect to provincial colleges, 8015-8018, 8024.

Would be a London not a metropolitan, college, 8029.

*Model Schools.* See *Saint Mark's Training College*.

*Physical Geography.*

The best subject for elementary schools; great number of students who pass in, 7926, 7982-7984.

*Private Adventure Schools.* See *Schools*.

*Pupil-teachers.*

Inferior teaching of, induced by Revised Code, 7930.  
After 1861, number fell from 13,000 to 6,000, 7979.

See *Saint Mark's College*.

*Revised Code.* See *Syllabus (Education Department)*.

*Saint Mark's College.*

Witness is principal of, 7903.

Foundation; students; science instruction, laboratory, &c.; science lectureships; reduction of science teaching by Government syllabus; students who have qualified as Department teachers, &c., 7904-7916, 7929, 7930.

Very numerous subjects have been taught at; present teaching is beyond Government syllabus, 7934-7936.

Possesses laboratory, &c., and is capable of giving more science instruction than it does, 7938-7943.

To extend science instruction in, there must be qualified candidates for admission, competent lecturers, encouragement to schoolmasters, reduction of certain subjects of examination, &c., 7944-7963.

CROMWELL, REV. J. G.—*St. Mark's College*—cont.

Students in, not entirely supplied by pupil-teachers; all are training for teachers; about 100 in college; not from any particular area, 7945-7948, 7993-7996, 8022.

Full at present; there was a steady decrease of entries from 1863 to 1869, 7978.

In model schools connected with, French and Latin are taught, the parents desiring it; fees from 15*s.* to 25*s.* per term, 7986, 7990.

Instruction in Greek in the college, 7991.

Receives from Government 4,000*l.* a year; from students' fees, 250*l.*; from National Society, 800*l.*, 7992-7995.

Positions and honours held by former students of, 8009, 8010.

A mischievous notion to suppose that masters were formerly too highly trained in, 8011-8013.

*Schoolmasters.* See *Teachers*.

*Schools.*

Physical geography should be taught in all schools, 7926.

Great want of competent teachers in private adventure schools, 7974.

See *Elementary Schools*.

*Science.*

Instruction, examinations, &c. in, in St. Mark's Training College; science reduced by Government syllabus, 7904-7910, 7917, 7918.

St. Mark's College is capable of giving more science instruction than it does, 7943, 7944.

Science (not that required by Science and Art Department) might be taught in elementary schools, 7985, 8030.

*Science and Art Department.*

Students and examinations under, in connexion with St. Mark's College, 7910.

Science required by, could not be taught in elementary schools, 8030.

*Science Examinations.*

Special examinations for teachers should be re-introduced, 7911-7913.

Great number of candidates who pass in physical geography, 7982.

*Science Schools.*

Better to establish science schools in the provinces than to bring men to London, 8027, 8028.

*Science Teachers.*

158 students of St. Mark's College qualified as teachers under Science and Art Department (1867-70), 7910.

Special examinations for, should be re-introduced, 7911-7913.

Students who could have a third year's training would become qualified for, 7964-7968.

If Government desire superior science teachers, they should train, and lodge them, in a special College, 8004.

Desirability of teaching method to, 8005, 8006.

Provincial science schools for, would be better than bringing men to London, 8028.

*Secondary Schools.*

Demand for specially trained teachers in, 7969-7971.

Geometry, chemistry, &c. might be taught in, but general education must also go on, 7986.

Latin will probably not be included in curriculum of; many parents desire that Latin may be taught, 7986.

*Students.*

Inferior class of students resulted from Revised Code, 7918, 7919.

Objection to Education Department examinations for, 7950-7963.

Students who have passed a lower class frequently recommended in preference to those who have passed a higher, 7962, 7963.

Third year's students might become qualified science teachers, 7964-7968.

A higher class of, in training colleges, might be objected to by Government, &c., 7975.

Great number of, who pass in physical geography, 7982.

Objections to students living in lodgings; they should enter a training college; if they leave for special instruction, it should be in the day-time, 7997-8004, 8007.

In country colleges, are mostly from the surrounding area, 8023.

See *Saint Mark's College*.



CROMWELL, REV. J. G.—cont.

*Syllabus (Education Department).*

Curtailment of, reduced instruction of students and pupil-teachers, and generated hostile feeling in teachers, 7907-7910, 7918, 7919.

General education more defective now than before passing of Revised Code, 7927, 7928.

Changes through, at St. Mark's College; present teaching beyond syllabus, 7929, 7930, 7934-7936.

Objection to requirement of, respecting history and commercial geography, 7950, 7951.

In consequence of, after 1861, some colleges were closed or nearly closed, and number of pupil-teachers fell from 13,000 to 6,000, 7979.

Revised Code happily at an end; the new code gives more encouragement to special subjects, 7985.

The best masters were trained in the period preceding the Revised Code, 8011-8013.

*Teachers.*

Hostile feeling among teachers upon withdrawal of augmentation grant, 7910.

Great demand for teachers; the supply will be met in a few years, 7960, 7969-7971, 8014, 8018, 8019.

If a better class be desired, a third year's course in special subjects is desirable, 7964-7968.

Masters of primary and secondary schools could be educated in same college, 7972.

Great want of competent teachers in private adventure schools, 7974.

The best were trained in the period preceding the Revised Code, 8011-8013.

If a science college were established for teachers after their two year's course, there could not be a large number attend, 8015-8018.

Many qualified teachers for smaller schools would come forward, if a special examination were framed, 8020, 8021.

*Training Colleges.*

Objection might be taken if part of college were occupied by students who paid higher fees than the others, 7975.

Could not do more than they do at present, 7976.

Highbury and Chichester Colleges were closed, and Chester and York Colleges nearly closed, after 1861, 7979.

Objections to papers set for students in, 7950-7963.

Desirability of a third year's special course in, 7964-7968.

Masters for primary and secondary schools could be educated in same college, 7972.

If students went from, to attend a science school, it should be in the day-time, 8007.

Not many teachers from, could be expected to enter a metropolitan science college; difficulties greater with respect to provincial colleges, 8015-8018, 8024.

RIGG, REV. JAMES HARRISON, D.D. (Index of his Evidence.)

*Age of Students.*

Ordinary students enter Wesleyan Training College at 18; voluntary candidates are 26 and upwards, 8041, 8042.

Boys of 13 to 16 might be selected for instruction in science schools; they should not be taught science only, 8060, 8091, 8092.

*Algebra.*

Not recognized in Education Department syllabus, 8035.

*Apparatus for Science Purposes.*

In 1856-7, no training college deficient in apparatus could send up candidates for examination in physical science, 8067.

*Children.*

Science instruction to, in schools of Wesleyan Training College, Westminster, 8033, 8070, 8071.

Trained teachers would be able to select boys for science schools, 8060, 8091, 8092.

Model schools for, at Wesleyan Training College, 8078, 8079.

Education of, restricted by Revised Code, 8083, 8084, 8088.

Must be taught by object lessons, &c., 8085-8087.

*College of Science (proposed).*

A third year's course for college students should be given in a special science college, 8045, 8046.

RIGG, REV. J. H.—*College of Science, &c.*—cont.

If established at South Kensington, Wesleyan Training College students could attend, and six or seven training colleges take advantage of it, 8049, 8050, 8053, 8054.

Great objection to students in, living in lodgings, 8051, 8052.

*"Economy."*

Objection to vagueness of, in Education Department syllabus, 8035.

*Education Department.*

In revising their syllabus, should gather opinions from persons in training colleges, Science and Art Department, &c., 8072-8077.

See *Syllabus (Education Department)*.

*Elementary Schools.*

Science taught in schools of Wesleyan Training College, Westminster. Many schools suffered from effects of Revised Code, 8033, 8070, 8071.

Children in, might, by properly trained teachers, be selected for science schools, 8060.

*Examinations.*

Good results have followed from the principle of individual examination in schools, 8083.

*Infants' Schools.* See *Wesleyan Training College*.

*Lodgings for Students.*

Great objection to students living in lodgings while attending a London college, 8051, 8052.

*London.*

Few schoolmasters could be expected to come to London for science training; desirable, if it could be done, 8065, 8066.

*Model Schools.* See *Wesleyan Training College*.

*Practical Instruction.*

In physical science, was recognized by Education Department syllabus in 1856-7, 8067.

*Revised Code.* See *Syllabus (Education Department)*.

*Schoolmasters.* See *Teachers*.

*Schools.*

The principle of individual examination in, has produced good results, 8083.

*Science.*

Taught in Wesleyan Training College, Westminster, to children and students; more instruction in, desirable, for male and female students, 8033-8040.

Science teaching was kept up in the college schools, notwithstanding influence of Revised Code, 8033, 8034, 8080-8082.

Course of instruction in Wesleyan Training College comprises two years; a third year desirable, if it could be given, 8044, 8045.

Many men of science, but few capable of teaching it, 8055.

Practical instruction in physical science was recognized in Education Department syllabus of 1856-7, 8067.

To introduce science more largely in training colleges, &c., Education Department syllabus must be revised, 8073-8077.

Boys in science schools should not be taught science only, 8091, 8092.

*Science and Art Department.*

Teachers, students, examinations, &c., connected with, in Wesleyan Training College, belong to Department, 8033.

To carry out objects of Department, science schools are necessary, 8057-8059.

Approval of experiment by Department of bringing teachers to London for practical instruction, 8066.

*Science Examinations.*

Of students of Wesleyan Training College, Westminster, 8033, 8034.

*Science Schools.*

If established in large centres, teachers could be furnished by proposed third year's course in training colleges, 8057-8060.

Other subjects besides science must be taught in these schools, 8090, 8091.

Teachers of high schools would be men selected from lower, 8092.

Higher science schools would be a national benefit, and would work harmoniously with training colleges, 8096, 8097.

Denominational bias would have no place in, 8098.



RIGG, REV. J. H.—cont.

*Science Teachers.*

If teachers of high quality are to be provided, there must be a third year's training in college, 8045.  
A special training for, most desirable; teaching faculty difficult to find, 8056.  
Supply of, might be furnished for science schools, by proposed third year's course; their general education should be continued, 8057–8060, 8090–8093.  
The best would be those who had received a thorough college training, 8061.  
Few schoolmasters could be expected to come to London for science training; desirable, if it could be done, 8065.  
Teachers of high schools would be men selected from lower, 8092.

*South Kensington.*

Six or seven training colleges could take advantage of a school of science at South Kensington, 8053, 8054.

*Students.*

Great objection to students living in lodgings, while attending a London college, 8051, 8052.  
The students of six or seven training colleges could attend a science college at South Kensington, 8053, 8054.  
If students are to remain a third year in a college, they must have a prospect of higher salary, and superior status, 8055, 8094, 8095.

*Syllabus (Education Department).*

Science instruction under, in Wesleyan Training College, Westminster, to 1862; kept up, notwithstanding influence of Revised Code, 8033, 8034, 8080–8082.  
Revised Code compressed school age within narrow limits, discouraged attendance at school after 10 or 11 years, and restricted education of children, 8083, 8084, 8088.  
Might be altered, to allow more science to be taught to training college students, 8035.  
Objection to "Economy" in; and to non-recognition of algebra, 8035.  
Course of instruction in Wesleyan Training College defined by; its defects have not been officially pointed out, 8036–8040.  
Science instruction formerly recognized in, was abolished by Revised Code; principle ought to be re-introduced; suggestions might be taken from Science and Art Department, 8067–8069, 8071–8077.  
Failures, since Revised Code, in reading, writing, and arithmetic, 8089.

*Teachers.*

Science instruction for teachers in Wesleyan Training College, 8033.  
Encouragement given for becoming, by Wesleyan Training College, 8043.  
Teachers in Wesleyan Training College not pre-eminent for denominational bias, 8098.

*Training Colleges.*

Six or seven colleges could avail themselves of a school of science at South Kensington, 8053, 8054.  
To introduce more science in, would necessitate revision of Education Department syllabus, 8073–8077.

*Wesleyan Training College, Westminster.*

Witness is principal of, 8032.  
Science teaching in, since foundation of college; Department teachers in; science instruction to children in college schools, and to students, 8033, 8034.  
Science teaching kept up by, notwithstanding influence of Revised Code, 8033, 8034, 8080–8082.  
More science instruction in, desirable, for female students; improving defects in syllabus, would allow male students more time for science, 8035–8040, 8062.  
General students in, begin at 18 years; voluntary students are 26 years and upwards, 8041, 8042.  
College course in, comprises two years; a third year's course desirable, which might be better given in a general science college, 8043–8048.  
Students of, could attend a science college established at South Kensington; not second year's students, 8049, 8050, 8053, 8054, 8063.  
Students in, have no more time than to pursue a straight line of preparation, 8064.  
Five schools connected with; one called a model school; also two model departments, comprising an infants' school, a juvenile school, and two senior schools, 8078, 8079.

UNWIN, REV. WILLIAM J., M.A., LL.D. (Index of his Evidence.)

*Age of Students.*

Children might be fairly instructed in reading, &c. by seven years; could commence science at 13 years, 8144–8148.

*Children.*

Two years might be saved in education of; might be fairly instructed in reading, &c. at seven, and begin science at 13 years, 8144–8148.  
Approval of Swiss schools for; and of Mr. Tacher's system, 8145, 8149–8155.

*College of Science.*

Special institution necessary for training science teachers, 8131, 8132.

*Continent.*

Approval of continental method of teaching geometry, 8110, 8111, 8140–8143.

*"Economy."*

Difficulty of teaching, for want of subject being properly defined, 8112–8116.

*Education Department. See Syllabus (Education Department).*

*Elementary Schoolmasters.*

Two years' college training for, not sufficient; three years desirable, 8117–8123.  
Homerton College students become schoolmasters, 8129.

*Elementary Schools.*

Modification of infant and juvenile schools desirable; science might be taught to children of 13 years, 8144–8148.  
Approval of, in Switzerland, 8149–8157.

*Euclid.*

Objections to, 8140–8143.

*Exhibitions.*

Desirable for science students in Homerton College, 8116, 8124.

*France.*

Approval of French method of teaching geometry, 8140.

*Geometry.*

Continental method of teaching, desirable in Homerton College, 8110, 8111.  
Objections to Euclid, 8140–8143.

*Homerton Training College.*

Witness is principal of, 8100.  
Science class in, in connexion with Science and Art Department, taught by one teacher, who also teaches other subjects, 8101–8107, 8127.  
Science taught in, as much as possible, 8108.  
Difficulty of teaching "economy" in, from its imperfect definition, 8112–8116.  
Two years' training in, insufficient; three desirable, 8117–8123.  
Exhibitions to induce students to remain in, another year, might succeed, 8124.  
Science would be better taught in, by special teachers, 8116, 8126–8128, 8133–8139.  
Students in, become teachers of elementary schools; most take Department science certificates, 8129, 8130.  
Science teachers could not be trained in; special institution necessary, 8131, 8132.  
Success of three months' instruction in, given by a Swiss teacher, 8155.

*Science.*

In Homerton Training College is taught as much as possible; special teachers desirable, 8108–8111, 8116, 8126–8128, 8133–8139.  
May be taught to children of 13 years, 8145.

*Science and Art Department.*

Science class in connexion with, at Homerton Training College, 8101–8107, 8127.  
Allusion to art scholarships and drawing teachers under, 8125, 8134.  
Desirable that teachers like those under Department should give science instruction in training colleges, 8116, 8126–8128, 8133–8139.  
Men who merely pass science examinations of, are not thereby duly qualified to teach, 8137–8139.

*Science Classes. See Homerton Training College.*

*Science Examinations.*

Not very difficult; those who merely pass should not be regarded as qualified teachers of science, 8137–8139.

*Science Students. See Homerton Training College.*



UNWIN, REV. W. J.—cont.

*Science Teachers.*

- One teacher (who instructs in other subjects) gives all the science instruction at Homerton College, 8105, 8127.
- Desirable that special science teachers should give instruction in training colleges, 8116, 8126–8128, 8133–8139.
- Could not be trained in such an institution as Homerton College; special institution necessary, 8131, 8132.
- Those who merely pass Department examination, should not be regarded as qualified for teaching, 8137–8139.

*Students.*

- Science exhibitions for, desirable, in training colleges, 8116, 8124.
- Two years' training of, for schoolmasters, insufficient; three desirable, 8117–8123.
- In Homerton College, become teachers of elementary schools; most take science certificates, 8129, 8130.

*Switzerland.*

Approval of Swiss primary schools, 8145, 8149–8155.

*Syllabus (Education Department).*

As affecting instruction in Homerton College, 8106–8116, 8140.

*Training Colleges.*

- Special teachers should give science instruction in, 8116.
- Science exhibitions in, desirable, 8116, 8124.
- Science teachers could not be trained in, 8131, 8132.
- See *Homerton Training College*.

*Tscher, Mr.*

Success of his system of instructing children, 8149–8155.

*Zurich.*

Approval of primary schools in, 8149–8155.

BOURNE, ALFRED, Esq., B.A. (Index of his Evidence.)

*Borough Road Training College.*

For male students; Science and Art Department classes in; students attend voluntarily; could not give more time to science, 8171–8188.

*British and Foreign School Society.*

- Witness is secretary of, 8160.
- Daily Lesson Books of society; science in them, and science teaching in society's elementary schools. Abbreviated lesson books necessitated by Revised Code, 8161–8168, 8194–8196.
- Science and Art Department classes and examinations at society's training colleges, 8169–8188.
- Students and scholars would profit by elementary science teaching in society's schools, 8189.
- Many former students of society have received Department certificates, and are teaching science classes in their own neighbourhoods, 8192, 8193, 8197, 8198.
- In society's colleges, science is taught by teachers of other subjects; these hold degree of Bachelor of Arts, 8199–8201.
- Science classes were instituted under, through action of Science and Art Department, 8202, 8203. No practical instruction given, 8204.

*Cooking.*

Taught in Stockwell Female Training College, 8169.

*Daily Lesson Books.*

Of British and Foreign School Society; science lessons in; reduced since Revised Code, 8161–8168, 8194–8196.

*Domestic Economy.*

Taught in training college at Stockwell, 8169, 8170.

*Elementary Schools.*

Of British and Foreign School Society; advantage to students and scholars of science being taught in, 8189, 8190.

*Laboratories.*

None for students in Borough Road training colleges, 8204, 8205.

*Practical Instruction.*

Science students in British and Foreign School Society's colleges do not receive laboratory instruction, 8204, 8205.

*Revised Code.*

Science lessons in British and Foreign School Society's school-books reduced in consequence of, 8164–8168.

BOURNE, ALFRED, Esq.—cont.

*Science.*

- In British and Foreign School Society's lesson books, in its elementary schools, and in its training colleges, 8161–8168, 8192, 8193, 8202–8204.
- Advantage to scholars and teachers of elementary science being taught in schools of British and Foreign School Society, 8189, 8190.

*Science and Art Department.*

- Classes under, in Borough Road and Stockwell training colleges, 8172–8188, 8197, 8198. Many former students now teaching under Department, 8192, 8193.
- Action of Department led to establishment of science classes at Borough Road College, 8202–8204.

*Science Classes.*

At Borough Road and Stockwell colleges, established through action of Science and Art Department, 8192, 8193, 8202–8204.

*Science Examinations.*

Result of, for Borough Road and Stockwell training colleges (1868–1870), 8176.

*Science Students.*

In Borough Road and Stockwell colleges; results of their examinations; attend voluntarily, and could not give more time to science. Many have become Department teachers, 8176–8187, 8192, 8193, 8197, 8198, 8204, 8205.

*Science Teachers.*

Many British and Foreign School Society's former students are now Department teachers, 8192, 8193, 8197, 8198.

*Stockwell Female Training College.*

Domestic economy taught in, 8169, 8170.

Science classes in, 8172.

*Training Colleges.* See *Borough Road Training College*. *Stockwell Female Training College*.

ROBINSON, REV. CANON, M.A. (Index of his Evidence.)

*Age of Students.*

- In training colleges, from 17 to 20 years; less experienced than Eton boys of 15 years, 8233, 8238, 8239.
- A boy of 13, who teaches, states opinions without thinking it necessary to give reasons, 8241.

*Cost of Science Instruction.*

Training colleges more expensive for secondary than for elementary schools; were buildings once provided, they would be partly self-supporting, 8230, 8231.

*Education Department.*

Might encourage science in training colleges by supplemental grants for specific subjects, 8284, 8286.

*Elementary Schools.*

- Endowments in, proposed to be used for exhibitions, to encourage longer stay at school, 8219.
- Training colleges more expensive for secondary than for elementary schools, 8230, 8231.

*Endowed Schools' Commission.*

Proposes to make science compulsory in all endowed schools. Cannot go farther, but would gladly receive suggestions in the matter, 8219–8221, 8229, 8251–8261.

Permission given in scheme of, to erect laboratories, 8254.

Power given to governors of schools by, to found exhibitions for students in training colleges, 8262.

*Exhibitions.*

- To encourage longer stay in elementary schools, proposed by Endowed Schools' Commission, 8219.
- In secondary schools, to induce students to enter training colleges for teachers, desirable, 8228, 8231.
- Power to found exhibitions given by Endowed Schools' Commission; tenable where trustees may select, 8262–8265.

*Government Grants in aid of Science.*

Science in training colleges would be encouraged by supplemental grants for specific subjects, 8284, 8286.

*Laboratories.*

Permission given for erecting, in scheme of Endowed Schools' Commission, 8254.

*Lodgings for Students.*

Isolation essential for students in training colleges; they should live in licensed lodgings, under supervision, 8232, 8236–8250.

*New Code.*

Promises well, 8213. Will encourage teachers to give more time to higher subjects, 8219.



ROBINSON, REV. CANON—cont.

*Payments on Results.*

Advantage of system of; should be extended to higher subjects, 8213.

In addition to, grants to training colleges for specific subjects desirable, 8284-8286.

*Practical Instruction.*

Not enforced, in respect to science teaching authorised by Endowed Schools' Commission, 8251-8261.

Universities might train teachers, but difficulty would be in practical part, 8269-8276.

*Revised Code.*

In some respects to be condemned; elementary subjects better taught under it, 8211-8218.

Small payment exacted by, from students in training colleges, 8280.

See *New Code*.

*Schoolmasters.*

Mechanical habits acquired by, 8239-8243.

*Science.*

Proposed by Endowed Schools' Commission to be compulsory in endowed schools; subjects, &c. left to governors, 8219-8221, 8229, 8251-8261.

Encouragement to science in training colleges might be given by supplemental grants for specific subjects, 8284-8286.

*Science and Art Department.*

Might encourage science in training colleges by supplemental grants for specific subjects, 8284.

Amount paid by, to training colleges in 1869, 8285.

*Science Colleges (proposed).*

Prospect of science colleges being established about the country; one at York, 8266, 8267. Not specially for science teachers, but they could be taught efficiently therein, 8268.

Maintenance in, not to be gratuitous; exhibitions should be provided; some students would pay, 8281-8283.

See *Training Colleges*.

*Science Teachers.*

An additional year's instruction in training colleges would produce good science teachers, 8222.

Must be properly trained; training colleges in connexion with secondary schools would produce a supply; exhibitions should be offered them, 8224-8228.

Demand for, will produce supply; but not at first, 8266.

Would be taught more efficiently in proposed science colleges than in training colleges, 8267, 8268.

*Secondary Schools.*

Training colleges in connexion with, would produce a supply of teachers; these colleges would be more expensive than those for elementary schools, 8224-8228, 8230, 8231.

*Students.*

In training colleges, are too gregarious; they should live in licensed lodgings, under supervision, 8232, 8236-8250.

Age of students in training colleges probably 17 to 20 years, 8233.

Success of students who have been educated in training colleges, 8234, 8235.

*Teachers.*

Position of, under revised and new codes, 8213-8218. Under latter, teachers may give more time to higher subjects, 8219.

Universities might train teachers, but the practical part would be difficult, 8269-8276.

Failure, as teachers, of scholars of great eminence, 8277-8279.

*Training Colleges.*

A third year's course in, desirable, to produce science teachers, 8222.

In connexion with secondary schools, would produce by degrees a supply of teachers, 8224-8228.

More costly for secondary than for elementary schools, but would be partly self-supporting, 8230, 8231.

Education in, would be much cheaper than in a university, 8231.

Advantage of students of training colleges living in lodgings, 8232, 8236-8245.

Students in, are from 17 to 20 years of age, 8233.

Moral success attained in training colleges, 8234-8237.

Corporate system of discipline and training in present training colleges, with a slight university element as regards habit of life, desirable for science students, 8236.

26060.

ROBINSON, REV. CANON—*Training Colleges*—cont.

If Government founded a training college, endowed schools would pay for training their own science masters therein, 8263, 8264.

Science teachers would be taught more efficiently in science colleges than in ordinary training colleges, 8267, 8268.

No payment for students in, who hold Queen's scholarships, except a small payment in some cases now under Revised Code, 8280.

Encouragement to science in, might be given by Education or Science and Art Department making supplemental grants for specific subjects, 8284, 8286.

*Universities.*

Might train teachers, but the practical part would be difficult; they aim at making scholars, not teachers, 8269-8276.

Want of teaching power in men who have taken highest university honours, 8277-8279.

*York and Ripon Diocesan Training College.*

Witness was formerly principal of, 8207.

Science was not much taught in the college, 8208-8210.

*York Science College.*

Proposal to establish, 8266, 8267.

FRASER, RIGHT REV. JAS., D.D., LORD BISHOP OF MANCHESTER. (Index of his Evidence.)

*Abbott's Ann.*

Excellent school at Abbott's Ann; due to zeal of Hon. and Rev. Samuel Best, 8303, 8307, 8308, 8311, 8312.

*Age of Scholars.*

Children in American schools enter at 5, and are supposed to remain until 18 years; from 5 to 9 in primary, and 8 to 14 years in secondary schools, 8297, 8326, 8327.

Even if children in rural schools remained until 13 years of age, extension of present programme would not be advisable, 8313.

Science, taught to children under 13 years, must be in a concrete rather than in an abstract form, 8316-8318.

*America.*

Text-books in America are wanting in scientific method, 8337, 8340.

Superficial information exhibited by people in America, 8338, 8339.

*American Schools.*

The system supposes children who enter at 5 years to remain until 18 years of age, but they do not so remain; there is no compulsion, 8297, 8298.

Too many subjects are taught in; scholars know little of anything well; contraction of programme contemplated at Boston, 8299, 8320.

Science teaching in, has had a mischievous effect, 8320-8323.

American primary schools lay a solid foundation secondary schools fail, 8325.

Children in American primary schools are from 5 to 9 years, in secondary schools from 8 to 14 years of age, 8326, 8327.

The system of passage from elementary to higher schools in America might be adopted here, 8341.

Energy and ambition to excel of American male and female teachers; contrast to those of England, 8357.

*Apparatus for Science Purposes.*

Difficulty in supplying schools with apparatus at present, 8317.

*Best, Hon. and Rev. Samuel.*

Efficiency of Abbott's Ann school; owing to zeal of Mr. Best, 8303, 8307, 8308, 8311, 8312.

*Botany.*

Intelligence of children developed by teaching of botany in Professor Henslow's school, 8303, 8319.

*Brewer, Dr.*

His "Knowledge of Common Things," formerly used in schools; it referred to practical purposes, not scientific considerations; similar book used in America, 8334, 8335, 8337.

*Chemistry.*

A subject to interest children, 8317.

Chemistry taught in Abbott's Ann rural school, 8311.



FRASER, RIGHT REV. J.—cont.

*Children.*

In America, children in primary schools are from 5 to 9 years, and in secondary schools from 8 to 14 years of age; theoretically, they remain until 18 years of age, 8297, 8326, 8327.

Present programme of schools is sufficient for children up to 14; should not be extended; abstract science instruction undesirable, 8313, 8328, 8329.

Children would be likely to be interested in chemistry, 8317.

Simple scientific explanation, not taking too wide a range, the most desirable for children, 8336, 8337.

*Compulsion.*

No compulsion in American schools, 8298.

Compulsory attendance in schools desirable, but the way is not clear at present, 8302.

*Coutts, Miss [now Lady] Burdett.*

Stimulus to science teaching in schools by prizes given by Miss [now Lady] Burdett Coutts, 8295, 8334, 8335.

*Dawes, Dean.*

Efficiency of King's Somborne school and Hereford Bluecoat School, owing to zeal of Dean Dawes, 8303–8306, 8309, 8310, 8312.

*Education Act.*

Cannot come into efficient operation until our power of producing teachers is multiplied, 8348.

*Elementary Schoolmasters.*

Greater efficiency of, desirable, but the way to that is not clear, 8302.

As the teacher is, so is the school, 8347.

Present means for training teachers insufficient, 8348.

Motives of masters to instruct their pupil-teachers were impaired by the Revised Code, 8356.

Energy and enthusiasm wanting in English teachers, as contrasted with American, 8357.

*Elementary Schools.*

Rural schools were but little affected by Revised Code; the elementary science taught previously in these schools was probably owing to prizes given by Miss Burdett Coutts, 8293–8295.

Compulsory attendance in, desirable, but the way not clear at present, 8302.

Excellence of schools at King's Somborne and Abbott's Ann, and the Bluecoat School in Hereford; owing to Dean Dawes and Mr. Best, 8303–8312.

Undesirable to add to present programme of instruction in elementary schools, 8313.

Geography is fairly taught in rural schools; physical geography, &c. must be taught in a concrete not an abstract form, 8316.

Secondary schools, to continue training of elementary schools, most desirable; no method now of passing from one to the other; American system superior in this respect, 8324, 8341–8344.

More education can be given in town schools than in rural schools, 8358.

See *American Schools*.

*Endowed Schools.*

Might all be put under one system, and graduated, 8342.

*England.*

Rareness of energetic school teachers in England, contrasted with teachers in America, 8357.

*Geography.*

Is fairly taught in rural schools, 8316.

See *Physical Geography*.

*Henslow, Professor.*

Allusion to his school in Suffolk, in which the intelligence of young children was developed by teaching of botany, 8303, 8319.

*Hereford Bluecoat School.*

Remarkable efficiency of the school, which was watched over by Dean Dawes, 8303, 8309, 8310.

*Infant Schools.*

Difficulty in getting children to attend in infant schools; with better methods of instruction more rapid progress might be made, 8330–8332.

*King's Somborne.*

Excellent school at, owing to energy of Dean Dawes, 8303–8306, 8312.

*Kneller Hall.*

Failure of Kneller Hall Government training college, 8350.

FRASER, RIGHT REV. J.—cont.

*Manchester.*

With some secondary schools, Manchester would possess all the elements for a graduated system of instruction, 8343, 8344.

Grammar school at Manchester; modification of it as a free school, 8345, 8346.

*Physical Geography.*

Taught in Abbott's Ann rural school, 8311.

If taught in rural schools it must be in a concrete not an abstract form, 8316.

But little physical geography taught in elementary schools visited by witness, 8359.

*Pupil-teachers.*

Under Revised Code, pupil-teachers entered training colleges with one third less preparation than before, 8355–8357.

*Revised Code.*

Rural schools were little affected by Revised Code; the elementary sciences previously taught was probably owing to prizes given by Miss Burdett Coutts, 8293–8295.

Tendency of Revised Code has been to narrow range of subjects; instruction probably sounder, 8352–8354.

Pupil-teachers, under Revised Code, entered training colleges with one third less preparation than before, 8355–8357.

*Rural Schools.* See *Elementary Schools*.*Secondary Schools.*

Secondary schools, to continue education of elementary schools, most desirable; no method now of passing from elementary to higher schools, 8324, 8341–8344.

The secondary schools of America fail, 8325.

With secondary schools, Manchester would possess all the elements for a graduated system of instruction, 8343, 8344.

*Science.*

The science taught in rural schools before Revised Code was probably owing to prizes given by Miss Burdett Coutts, 8295, 8334, 8335.

Science teaching in Hereford Bluecoat School, Professor Henslow's school, &c., 8303–8312.

Objection to introduction of abstract science, or extension of present programme, in elementary schools, 8313, 8328, 8329.

Science must be taught to children more in a concrete than an abstract form, 8316.

Chemistry is a subject likely to interest children, 8317.

Science teaching in elementary schools of America has had a mischievous effect, 8320–8323.

Simple scientific explanation, not taking too wide a range, desirable for children, 8336, 8337.

Deficiency, in scientific method, of American text-books, 8340.

With a graduated system of schools, elementary might be connected with higher scientific instruction, 8343.

Discretion requisite in introducing science into training colleges; present programme wide enough, 8351, 8352.

*Teachers.*

In America, the teacher of a high school is supposed to teach almost every knowable thing, 8299.

See *Elementary Schoolmasters*.

*Text-books.*

Dr. Brewer's "Knowledge of Common Things" formerly much used; similar text-book used in America, 8334, 8335, 8337.

Deficiency of American text-books in scientific method, 8340.

*Training Colleges.*

Could turn out 1,600 teachers per annum; insufficient provision for number required under Education Act, 8348.

Failure of Kneller Hall training college, 8350.

To introduce science in training colleges would require great discretion; present programme is wide enough, 8351, 8352.

Under Revised Code, pupil-teachers entered training colleges with one third less preparation than before, 8355–8357.

SANDFORD, SIR FRANCIS R. (Index of his Evidence.)

*Age of Scholars.*

Between 7 and 13 years children pass the six standards, 8400–8405.

Children of 10 years might be brought up to the geography required by standard iv., but they are not now brought up to it, 8420–8433.



SANDFORD, SIR F. R.—cont.

*Assistant Inspectors.* See *Inspectors.*

*Children.*

In elementary schools, children pass the six standards between 7 and 13 years, 8400–8405.

Grants for school children under New Code, 8415–8418, 8436–8445, 8459–8463.

Few children in schools under Education Department take extra subjects, 8419–8429.

Children of 10 years might be brought up to the geography required by standard iv., but they are not now brought up to it, 8420–8433.

Extra subjects must be taught now to children in elementary schools, 8430–8440.

Music to be taught to children under New Code; one other extra subject might also be made compulsory, 8451–8458.

*Cost of Instruction.*

Successful schools cost more than unsuccessful, 8443–8445.

Payments for instruction of children by Education Department, 8415–8418, 8436–8445, 8459–8463.

*Education Department.*

School inspectors of, might supervise science classes to some extent, 8360–8364.

Works more in connexion with Science and Art Department than formerly, 8365, 8366.

Science to be taught in elementary schools under Education Department, 8367–8369, 8377–8384.

Might derive assistance, regarding inspection, from Science and Art Department, 8385, 8386.

Promotion of science instruction for schoolmasters by Education Department, 8398, 8399.

*Elementary Schoolmasters.*

Inspectors' assistants have been elementary schoolmasters; many are acquainted with science, 8393–8397.

Instruction in science for schoolmasters to be promoted by Education Department, 8398, 8399.

*Elementary Schools.*

Science to be taught in schools under Education Department; examinations to be by papers, 8367–8369, 8377–8384.

Children in, pass the six standards between 7 and 13 years, 8400–8405.

Allowances for children in, under New Code, 8415–8418, 8436–8445, 8459–8463.

Extra subjects in, under New Code; if pupils are not presented in these subjects, the standard of ordinary subjects might be raised, or grant withheld, 8406–8440, 8453.

Schools which take up extra subjects would require a more skilled staff, and be more expensive, 8441–8445.

Standards in, apply to half-time and whole-time schools; half-time schools often do as well as whole-time, in reading, writing, and arithmetic, 8446–8449.

Compulsory teaching of music in, under New Code, 8451–8458.

Inducement in, to pass some children in extra subjects, to compensate for loss of payment by failure of other children, 8459–8463.

Subjects taught in, under Mr. Corry's minute, 8464.

Table showing number of schools to which grants were made for proficiency in "specific subjects" (1870), 8468 (note).

*Endowed Schools' Commission.*

Extended instruction expected to result from the Endowed Schools' Commission; no difficulty in providing inspectors to supervise it, 8387.

*Inspection.*

Inspection of science classes might be undertaken to some extent by present school inspectors, 8360–8364.

Education Department might derive assistance, as to inspection, from Science and Art Department, 8385, 8386.

Advantage of concentration in inspection of schools under one department, 8387–8392.

*Inspectors of Schools.*

Might supervise science classes to some extent; few have had special scientific education, 8360–8364, 8408, 8411.

Inspectors refer to head-quarters if asked to examine in subjects they do not understand, 8368, 8375.

Inspectors have not been selected hitherto for their scientific attainments; desirable they should be in the future, 8370–8376, 8409–8412.

Inspectors' assistants are schoolmasters; many might be found acquainted with science, 8393–8397.

SANDFORD, SIR F. R.—cont.

*Music.*

Compulsory teaching of music in schools under New Code; no reason why so great a preference should be given to music, 8451–8458.

*New Code.*

Science to be taught in elementary schools under New Code; physical geography and animal physiology specified, 8367, 8377–8384.

The sixth standard of the New Code is like a seventh of the old, 8405.

Inspectors generally would not be competent to examine in scientific subjects under New Code, 8408.

Allowances for attendance and passing under New Code; grants might be increased for special and reduced for ordinary standards; the code varies from year to year, 8415–8418, 8436, 8459–8463.

Compulsory teaching of music under New Code; similar arrangement might be made with regard to extra subjects, 8451–8458.

*Physical Geography.*

A subject for the extra grant under the New Code, 8377.

*Physiology (Animal).*

Under New Code, a subject for the extra grant, 8377.

*School Inspectors.* See *Inspectors.*

*Schoolmasters.* See *Elementary Schoolmasters.*

*Schools.*

Advantage of a concentration of inspection of schools under one department, 8387–8392.

See *Elementary Schools.*

*Science.*

Science to be taught in elementary schools under Education Department; examinations to be by papers; physical geography and animal physiology specified, 8367, 8369, 8377–8384.

*Science and Art Department.*

Works more in connexion with Education Department than formerly, 8365, 8366.

Might render assistance, in the matter of inspection, to Education Department, 8385, 8386.

*Science Classes.*

School inspectors might undertake supervision of science classes to some extent, 8360–8364.

*Science Examinations.*

To be by papers in elementary schools under Education Department, 8368, 8369.

NORRIS, THE REV. CANON. (Index of his Evidence.)

*Age of Scholars.*

In the Black Country evening schools pupils ranged from 12 to 23 years, 8484.

Systematic instruction in science should not be given in elementary schools to children under 12 years, 8529.

*Agriculture.*

Instruction bearing on agriculture formerly given in certain rural schools, 8469.

*Apparatus for Science Purposes.*

Chemical cabinets, laboratories, &c. formerly used in the Black Country elementary schools, 8528–8529.

*Belgium.*

Mining system of Belgium more scientific than that of Staffordshire, 8505.

*Biography.*

Importance of biography greater than science in elementary instruction, 8531–8534, 8570, 8571.

*Black Country.*

Machine drawing formerly taught in the Black Country evening schools; no mining instruction given; attempted, but failed, 8483, 8501–8505.

*Chemistry.*

School for chemistry formerly at Stoke-upon-Trent, 8466.

Instruction in chemistry formerly given in certain rural schools, and in the Pottery districts, 8469, 8489, 8509–8513.

Popularity of chemistry in Department examinations, 8513.

*Children.*

Instruction in science formerly given to children in elementary schools at Stoke-upon-Trent, Acton, &c., 8465–8471, 8492–8500, 8514–8520.

In elementary schools, children should receive casual, but not systematic, instruction in science, 8472–8474, 8499, 8500, 8526–8568.



NORRIS, REV. CANON—*Children*.—cont.

More scientific instruction might be given to children in evening than in day schools, especially in mining districts, 8485, 8486.

In the teaching of children, humanity is more essential than physical science, 8531–8534.

Importance of instructing children in biography, history, and geography, 8531–8534, 8570, 8571, 8584–8598.

More regular attendance of children, longer stay at school, and attainment of higher standards, may be expected to result from the Education Act, 8600.

Where children stay at school till the advanced age, the extra subjects might be taken up, 8604.

*Drawing (Machine).*

Instruction in machine-drawing formerly given in elementary schools near Birmingham, 8469, 8483.

*Education Act.*

Good results to be expected from, 8574, 8599–8604.

*Elementary Schoolmasters.*

Should have an interest in science, and opportunities for studying it; and should be able to turn the attention of boys towards science, and to select the best for special instruction, 8474, 8476, 8479, 8499, 8500, 8506, 8507, 8536, 8538.

Not sufficient encouragement for teachers to study science, 8477.

Training colleges should have scientific inspection, grants for laboratories, &c., for instructing teachers, 8478, 8479, 8507, 8508.

Masters were formerly forbidden to engage in evening work, 8487.

Objections to their living in lodgings in London while training in science, 8521.

Work would be found in centres of industry for masters trained in science, 8522.

*Elementary Schools.*

Science taught in elementary schools of Cheshire, Staffordshire, Shropshire, and Kent, before Revised Code, 8465–8471, 8475, 8490, 8491–8498.

Objection to science being more than casually taught in; teachers should be able to awaken the intelligence of children, and select for technical training those of special promise; biography, history, and geography more important to children than science, 8472–8474, 8476, 8499, 8500, 8506, 8507, 8526–8568, 8575, 8584–8598.

In the Black Country elementary schools no mining instruction was given, 8501, 8502.

Objection to the reading lesson in elementary schools being made the medium of instruction in applied science, 8539–8568.

From the Education Act, good results may be expected in elementary schools; moral training must be attended to before scientific; more regular attendance, and longer stay at school, may be expected, 8574, 8584–8598, 8599–8604.

Under New Code, schools may obtain maximum grant without taking the higher subjects, 8607.

Schools where children stay till the advanced age could take extra subjects, 8604.

See *Evening Schools*.

*Evening Schools.*

Chiefly for making up for neglect in the elementary schools; drawing taught in a few, in the Black Country, 8480–8485.

More science might be taught in the evening than in the day schools, especially in mining districts, 8485, 8486.

The Black Country evening schools were not taught by certificated masters, but by special teachers, who had other occupations; apparatus used in these schools, 8487–8489, 8523–8525.

No mining instruction formerly given in elementary schools of the Black Country, 8503.

See *Elementary Schools*.

*Geography.*

Desirability of teaching plain geography in elementary schools; physical geography might follow, 8584–8598.

*Geometry.*

Instruction in geometry formerly given in elementary schools near Birmingham, 8469.

*Government Grants in aid of Science.*

Grants should be made to training colleges for laboratories, &c., for instruction of teachers, 8478.

*History.*

Importance of teaching history in elementary schools, 8598.

## NORRIS, REV. CANON—cont.

*Inspection.*

To promote scientific education of teachers, training colleges should be placed under scientific inspection, and have grants for laboratories, &c., 8478.

*Laboratories.*

Grants for laboratories, &c. should be made to training colleges, for instruction of teachers, 8478.

*Lodgings.*

Objection to teachers living in lodgings while studying science in London, 8521.

*Mining.*

Elementary science formerly taught in schools in mining districts, 8469.

Desirability of teaching science in the evening schools of mining districts, 8485, 8486.

No mining instruction formerly given in the Black Country elementary schools; lectures were attempted, but were not attended, 8501–8506.

If mining processes were more scientific, instruction of workmen would follow, 8505, 8579, 8580.

Belgian system of mining more scientific than that of Staffordshire, 8505.

*New Code.*

Elementary schools may obtain maximum grant under New Code without taking the higher subjects, 8607.

*Pottery Districts.*

Chemistry class formerly held in; collapsed, 8489, 8509–8513.

*Revised Code.*

Scientific instruction, formerly given in elementary schools, collapsed under Revised Code; not to be regretted, 8470, 8471, 8475, 8490.

Examination in reading under Revised Code, 8562–8565.

Instruction in geography should be given as was done before Revised Code, 8584.

See *New Code*.

*Rich, Lady.*

Scientific instruction in elementary school at Acton promoted by Lady Rich, 8496, 8498.

*Royal School of Mines.*

Intermediate schools wanted between School of Mines and ordinary elementary schools, 8521, 8522.

*Science.*

Science formerly taught in elementary schools in Cheshire, Staffordshire, Shropshire, and Kent; collapsed since Revised Code, and not to be regretted, 8465–8471, 8475, 8483, 8492–8498, 8514, 8520.

Science should not be systematically taught in elementary schools; teacher should be able to awaken the intelligence of children, and to select some for special technical training; science less important than humanity, 8472–8474, 8476, 8499, 8500, 8506, 8507, 8526–8568, 8575, 8584–8598.

More science might be taught in evening than in day schools, especially in mining districts, 8485, 8486.

No science instruction given in the Black Country elementary schools; lectures on mining were tried, but they failed, 8501–8504.

Belgian system of mining more scientific than that of Staffordshire, 8505.

Schools wanted which would touch on one side the elementary schools and on the other the Royal School of Mines, 8521, 8522.

Chemical cabinets, laboratories, &c. were formerly used in the Black Country elementary schools, 8523–8525.

Scientific instruction less important to children than moral instruction, 8574.

*Science Examinations.*

Inorganic chemistry the most popular of the Department examinations, 8513.

*Science Teachers.*

The teachers of the Black Country evening schools were mining agents, chemists, &c., 8486–8489.

See *Elementary Schoolmasters*.

*Staffordshire.*

Mining in Staffordshire less scientific than in Belgium, 8505.

See *Black Country*.

*Training Colleges.*

To encourage scientific instruction of teachers, training colleges should have scientific inspection, grants for laboratories, &c., 8478, 8479, 8507, 8508.



**WATKINS, THE REV. FREDERICK.** (Index of his Evidence.)

*Age of Science Students.*

A foundation of scientific knowledge might be imparted to children of 10 to 13 years, 8619, 8620.

*Children.*

The elements of scientific knowledge may be imparted to children of 10 to 13 years, 8619, 8620.

Present elementary school system does not cultivate habits of observation in children, 8655-8661.

Children of 7 to 8 years will now have to pass the first standard, 8699, 8700.

*Compulsion.*

Compulsion is necessary to secure attendance in elementary schools, 8701, 8702.

*Cost of Instruction.*

Payments to masters, &c. in elementary schools, 8672-8675.

*Education Department.* See *Elementary Schools.*

*Elementary Schools.*

Hardly any science has been taught in schools under Education Department; more general intelligence in the scholars before Revised Code, 8608-8615, 8621.

The merest elements of science might be taught in elementary schools to children of 10 to 13; subjects might be physiology, geography, topography, chemistry, in town schools; botany and agriculture in agricultural districts; and domestic economy, 8616-8620.

There are schools where every child passes in the three subjects of reading, writing, and arithmetic; these are rare, 8622-8631.

Encouragement to higher teaching in, under New Code; the deductions render this encouragement somewhat illusory, 8623-8633, 8668-8671, 8676-8686, 8719, 8720.

Evening schools (under witness's inspection) are below the character of the day schools, 8634-8640, 8662.

Doubtful if any instruction relating to mining is given in elementary schools of mining districts; this would be invaluable, 8647, 8648, 8651, 8697.

Nothing in present system of, to cultivate habits of observation, 8655-8661.

The 15s. limit operates partly as a check in, but more than one extra subject could not be expected, 8668-8671.

Cost of conducting, 8672-8675.

Maximum grant for, can be obtained by three fourths of the children passing in reading, writing, and arithmetic, without extra subjects, 8679-8686.

Desirable that more time should be given in, to subject-matter of lessons, 8687-8693, 8708-8713.

The tendency is to make attendance more regular in, but compulsion is necessary, 8701, 8702.

No reason why science should not be taught in, but encouragement must be given to teachers, 8714-8720.

*Elementary Schoolmasters.*

Are men of intelligence; desirable they should be able to teach science, but difficult for them to find time for studying it; they must be encouraged, 8649-8661, 8665, 8714-8720.

Payments to schoolmasters, &c., 8672-8675.

Are qualified to teach the extra subjects which are taught now, 8676-8678.

Syllabus of training colleges for schoolmasters should include science, 8721, 8722.

*Evening Schools.* See *Elementary Schools.*

*Geology.*

No matters of geological observation are pointed out to children in schools in witness's district, 8658-8661, 8714-8718.

*Mining.*

Doubtful if any special scientific instruction is given in elementary schools in mining districts; such instruction would be invaluable, 8647, 8648, 8651, 8697.

Men engaged in mining are reckless rather than ignorant, 8694-8698.

*New Code.*

Encouragement by New Code of advanced teaching in elementary schools by payments for extra subjects; deductions render this somewhat illusory, 8623-8633, 8668-8671, 8676-8686, 8719, 8720.

New Code has limited the number of attendances at present, but will afterwards make the children attend more regularly, 8633.

See *Revised Code.*

**WATKINS, REV. F.—cont.**

*Revised Code.*

The general intelligence of children was better cultivated before Revised Code, 8614, 8615.

No encouragement under Revised Code to teach geography or grammar, 8623.

See *New Code.*

*Science.*

Hardly any science is taught in the elementary schools under Education Department, 8608-8613, 8621.

Only the merest elements of science can be taught in elementary schools; the subjects might be physiology, geography, topography, chemistry, botany, agriculture, and domestic economy, 8616-8618, 8703-8708.

Elements of science might be imparted to children of 10 to 13 years, 8619, 8620.

Prospect of scientific instruction being given in elementary schools under New Code, 8623.

Doubtful if any special instruction in science relating to mining is given in schools of mining districts; such instruction would be invaluable, 8647, 8648, 8651, 8697.

If children are to be instructed in science, teachers must be encouraged, 8714-8720.

Training colleges for teachers should include science in their syllabus, 8721, 8722.

*Teachers.* See *Elementary Schoolmasters.*

*Training Colleges.*

Should include science in their syllabus, 8721, 8722.

**ELLIS, WILLIAM, Esq.** (Index of his Evidence.)

*Age of Scholars.*

In Birkbeck schools children are from 6 to 14 years of age, 8729.

Infant school children may be taught elementary social science, 8732.

Instruction in chemistry and physiology may be begun with children of 9 years of age, 8741.

*Birkbeck Schools.*

Formation of, suggested by witness, 8725.

Establishment of, in 1848; scholars from 6 to 14 years of age; distinguishing characteristic, the teaching of elementary social science, 8726-8736.

Elementary chemistry and physiology taught in, 8737-8741.

Social science text-book, written by witness, used in Birkbeck schools, 8756.

*Chemistry.*

Teaching of, in Birkbeck schools, 8739-8741.

*Children.*

In Birkbeck schools children are from 6 to 14 years of age, 8729.

Method of teaching of social science to children in Birkbeck schools; advantages of such teaching, 8730-8736, 8750-8752.

*Elementary Schools.*

Importance of teaching social science in, 8751, 8752.

Scientific instruction in, should be blended with instruction in the science of conduct, 8756 (*letter*).

*Examinations.* See *Science Examinations.*

*Inspectors of Schools.*

School inspectors ought to observe and report upon the amount of knowledge of the science of conduct exhibited in schools, 8756 (*letter*).

*Lectures.*

Mr. Ellis's lectures on social science at South Kensington Museum, &c., 8742, 8755.

*Physiology.*

Teaching of, in Birkbeck schools, 8739, 8740.

*Radnor, Earl of (late).*

Was patron of the first Birkbeck school, 8725.

*School Inspectors.* See *Inspectors of Schools.*

*Schools.* See *Elementary Schools.*

*Science.*

Elementary chemistry and physiology taught in Birkbeck schools, 8737-8741.

Instruction in general science in elementary schools should be blended with instruction in the science of well-being, 8756 (*letter*).

See *Social Science.*

*Science and Art Department.*

A Department examination in social science would do no harm, 8743-8749.



ELLIS, W., Esq.—cont.

*Science Examinations.*

Social science might be added to Department examinations; subject difficult to introduce in examination papers, 8743-8749, 8755.

*Social Science.*

In Birkbeck schools teaching of social science is a distinguishing feature; method of teaching; text-book; should be taught so as to interest children, 8730-8733, 8755, 8756.

Teachers of, who have been instructed by witness, 8733, 8734.

Lectures on, by witness, at South Kensington, &c., 8742.

Might be made a Department subject, but difficult to introduce in examination papers, 8743-8749, 8755.

Instruction in the science of conduct is easy to learn; it should be blended with general scientific instruction in elementary schools, 8756 (*letter*).

*South Kensington Museum.*

Lectures on social science at, 8742, 8755.

*Teachers.*

Importance of good teachers of social science; teachers trained by witness, 8731-8734, 8751, 8753, 8754.

Teachers of elementary science in Birkbeck schools, 8739, 8741, 8756.

*Text-books.*

Social science manual used in Birkbeck schools, 8756.

*Training Colleges.*

Importance of teaching social science in, 8751-8754, 8756 (*letter*).

JARMAIN, GEORGE, Esq. (Index of his Evidence.)

*Age of Science Students.*

Science can be taught to children of 11 to 13 years, 8922-8930.

*Agricultural Chemistry.* See *Chemistry*.

*Apparatus for Science Purposes.*

No grant should be made to classes deficient in science apparatus, 8959-8966, 8988, 8989.

Fair amount of apparatus at Huddersfield Mechanics' Institute, 8982.

For elementary schools chemistry apparatus might be furnished for 5*l.*, 8987.

*Apprenticeship of Science Students.*

Desirability of science teachers serving an apprenticeship as pupil teachers, 8844-8853, 8905-8907, 8915, 8910, 8931-8940.

*Artizans.*

Mechanics' institutes the best places for teaching science to artizans, 8866, 8867.

Fees paid by artizans at Huddersfield Mechanics' Institution, 8880, 8986.

Two thirds of those attending the technical classes in Yorkshire are artizans, 8901, 8994, 8995.

In witness's general science classes about three fourths are artizans, 8994, 8995.

*Birmingham.*

A desirable centre for instruction of science teachers, 8957.

*Bleaching.*

Formation of classes for instruction in the chemistry of bleaching, &c., 8889-8891.

*Certificates.*

Not desirable for teachers to hold certificates in many subjects, 8908-8910.

*Chemistry.*

Teaching of chemistry, as applied to dyeing, scouring, and bleaching, in Yorkshire, 8891.

A practical Department examination in chemistry for advanced stage desirable, 8904, 8990-8993.

Chemistry can be taught to boys of 11 to 13 years, 8925.

Desirability of establishing classes for agricultural chemistry, 8998.

*Children.*

Elementary science can be taught to children at 11 to 13 years, 8922-8930.

Boys like science; the best boys in science are also the best in other subjects, 8927-8929.

Science instruction could not be given to children in half-time schools; it must be taught in night classes, 8967-8971.

A large number of boys attend the Huddersfield Mechanics' Institute; proportion of half-timers is small, 8972, 8973.

JARMAIN, G., Esq.—cont.

*Contributions for Science Purposes.*

Manufacturers would be likely to aid in the formation of technical classes, 8898, 8899.

*Dyeing.*

Formation of classes for instruction in the chemistry of dyeing, &c., 8889-8891.

*Education Department.*

Formerly gave no aid to evening classes unconnected with day schools; benefit from withdrawal of this rule 8974-8977.

*Elementary Schoolmasters.* See *Schoolmasters*.

*Elementary Schools.*

Science can be taught in elementary schools to children of 11 to 13 years, 8922-8930.

In elementary schools, the best boys in science are best in other subjects; 8929.

Science instruction could not be given in half-time schools, 8967-8970.

*Evening Classes.* See *Science Classes*.

*Fees.*

Fees paid at Huddersfield Mechanics' Institute, 8880, 8986.

*Field Clubs.*

Huddersfield Literary and Scientific Society's field club for geology, botany, &c., 8983, 8984.

*Government Grants in aid of Science.*

Government should aid colleges for training science teachers, 8958.

Grants should be withheld from schools deficient in science apparatus, 8959-8966, 8988, 8989.

*Haley Hill Working Men's College.*

Technical classes at, 8891.

*Halifax.*

Technical classes at, 8891-8894.

*Honours.*

Objection to teachers who go to South Kensington for instruction being compelled to take an honours' paper in two departments, 8949-8954.

*Huddersfield.*

Mechanics' Institute at Huddersfield; attended largely by boys; science classes, apparatus, library, &c., 8842, 8876-8882, 8972, 8973, 8982, 8986.

Classes for chemistry of dyeing, bleaching, and scouring at Huddersfield, 8891-8894.

Literary and Scientific Society of Huddersfield; study of botany, geology, &c. in, 8983, 8984.

*Inspection.*

Inspection of schools, independently of inspection during examination, not necessary, but desirable, 8919-8921.

*Laboratory.*

Instruction in laboratory work given to teachers at Leeds, 8862-8865; at South Kensington, 8941-8945.

*Leeds.*

Practical science instruction for schoolmasters at Leeds, 8862.

Technical classes at, 8891-8895.

*Manchester.*

A desirable centre for instruction of science teachers, 8957.

*Manufacturers.*

Desire of manufacturers for establishing technical classes, 8898, 8899.

*Mechanics' Institutes.*

The best places for teaching science to artizans, 8866, 8867.

Science teaching in mechanics' institutes of Yorkshire, before establishment of Department examinations, 8868.

Committees of, are anxious to extend scientific instruction, 8883-8888.

Mechanics' institutes will profit by withdrawal of regulation which granted aid only to evening classes connected with day schools, 8974-8977.

See *Huddersfield*.

*Night Classes.* See *Science Classes*.

*Practical Instruction.*

Students who have practically assisted lecturers do well in examinations, and make the best teachers, 8845-8851.

Instruction in laboratory work, analysis, &c. given to schoolmasters at Leeds, 8862-8865.

A Department examination in practical science desirable, 8904.

Grants should not be made to classes deficient in means of giving practical instruction, 8959-8966, 8988, 8989.



JARMAIN, G., Esq.—cont.

*Pupil Teachers.*

Desirability of science teachers serving an apprenticeship as pupil teachers, 8844-8853, 8905-8907, 8915, 8916, 8931-8940.

*Schoolmasters.*

Science instruction for, in Leeds, Bradford, &c.; practical instruction given to, at Leeds, 8854-8866.

*Schools.*

Inspection of schools, independently of inspection during examination, not necessary, but desirable, 8919-8921.

See *Elementary Schools.*

*Science.*

Mechanics' institutes the best places for teaching science to artisans, 8866.

Desire of committees of institutes in Yorkshire to promote science, 8883-8888.

Teaching of science in schools would improve education in general subjects, 8922-8930.

*Science and Art Department.*

Allusion to letter to Department respecting technical classes in Yorkshire, 8890, 8891.

Approval of science system of Department, 8912.

See *Science Examinations.*

*Science Classes.*

In Huddersfield Mechanics' Institute; teachers, students, &c., 8842, 8876-8882.

Students who assist lecturers to science classes usually make the best teachers, 8845, 8851.

Twenty or thirty a sufficient number for a science class, 8847.

Science classes in Yorkshire before establishment of Department examinations; improvement since, 8868-8875.

Grant should be withheld from science classes deficient in apparatus, 8959-8966, 8988, 8989.

Half-time school children can only be instructed in science in night classes, 8967-8971.

In witness's science classes about three fourths are artisans, 8994, 8995.

Classes for agricultural chemistry would be a great benefit to farmers, 8998.

See *Technical Classes.*

*Science Colleges.*

Teachers might be trained in a science college which combined instruction with practice in teaching, 8937-8940.

Science colleges should be located in Birmingham, Manchester, &c., 8957.

Government should aid colleges for training science teachers, 8958.

*Science Examinations.*

Improved science teaching since establishment of Department examinations, 8874, 8875, 8978, 8979.

Department examinations are a fair test of acquirements; practical examinations desirable; this might be done in chemistry for the advanced stage, 8904, 8990-8993.

Department examinations not a sufficient test for science teachers, who might be questioned on the art of teaching, 8844, 8912-8918, 8931, 8932, 8981.

*Science Schools.* See *Science Classes.*

*Science Students.*

A pupil teachership desirable for students who are to become teachers, 8844, 8905.

Students who assist lecturers with experiments, &c. usually make the best teachers, 8845-8848.

Students willingly assist lecturers, without remuneration, 8849-8851.

Students should not be allowed to become science teachers without having served as pupil teachers; improvement would result from training in a college which combined instruction with practice in teaching, 8853, 8905-8907, 8915, 8916, 8931-8940.

Mechanics' institutes the best place for artizan science students, 8866.

Fees paid by science students at Huddersfield, 8880, 8986.

Instruction given to, in the chemistry of dyeing, scouring, and bleaching, in Yorkshire, 8889-8895, 8901.

Improvement in students since establishment of Department examinations, 8979.

*Science Teachers.*

A pupil teachership of one or two years desirable for training; Department examinations not a sufficient test, 8844, 8905.

The best teachers are those who have previously assisted lecturers with experiments, &c., 8845-8851.

JARMAIN, G., Esq.—*Science Teachers.*—cont.

Science teachers should be compelled to serve previously as pupil teachers; more desirable than training in colleges, unless instruction were combined with practice in teaching, 8853, 8905-8907, 8915, 8916, 8931-8940.

Better qualified since establishment of Department examinations; this does not refer to teachers who have merely passed the advanced stage, 8875, 8979.

Two pupil teachers are sufficient for one science teacher, 8996, 8997.

Science teachers should confine themselves to one group of subjects, 8908-8910.

Desirable that examinations of science teachers should comprise questions in the art of teaching, 8913, 8914.

Advantage derived by the teachers who go for instruction to South Kensington, 8941-8945.

Teachers of sciences affecting special industries should be selected in turn to go to South Kensington; objections to selection by honours' paper; selection by examination necessary in physics and biology, 8955.

Several centres of instruction desirable for training science teachers, 8957, 8958.

*Scouring.*

Formation of classes for instruction in the chemistry of scouring, &c., 8889-8891.

*South Kensington.*

Advantage derived by science teachers who go for instruction to South Kensington, 8941-8945.

Teachers of sciences affecting special industries should be invited in turn to South Kensington in preference to other teachers, 8947, 8948, 8956.

Objection to teachers who go to South Kensington for instruction being compelled to take an honours' paper in two departments, 8949-8954.

For physics and biology, the selection of teachers to go to South Kensington might be made by examination, 8954, 8955.

*Technical Classes.*

Classes formed in Halifax, Huddersfield, and Leeds, for instruction in the chemistry of dyeing, &c., 8889-8895.

Desirability of technical instruction believed in by manufacturers, 8898.

Artisans form two thirds of the students in the Yorkshire technical classes, 8901, 8994, 8995.

*Training Colleges.* See *Science Colleges.*

*Yorkshire.*

Desire of manufacturers in Yorkshire to promote technical instruction, 8898, 8899.

See *Huddersfield, &c.* *Science Classes.*

FOSTER, P. LE NEVE, Esq. (Index of his Evidence.)

*Age of Students.*

Students under 16 not admitted to Society of Arts' examinations, 9002.

*Apparatus for Science Purposes.*

Little use of, in mechanics' institutes, before 1852, 9017-9027.

*Examinations.*

Establishment of examinations by Society of Arts; subjects, &c., 9002.

Preliminary test for candidates for Society of Arts' examinations, 9035, 9042, 9048-9052.

See *Science Examinations.*

*Examiners.*

No difficulty in providing Society of Arts' examiners; they are paid by the Society, 9043, 9044.

*Government.* See *Science and Art Department.*

*Huddersfield.*

Society of Arts' examinations at Huddersfield, 9002.

Among mechanics' institutes in 1852, Huddersfield was one of the best as respects science classes, 9017.

*Local Boards.*

Candidates for Society of Arts' examinations tested by, 9035, 9042, 9048-9052.

*Mechanics' Institutes.*

Union of, for educational purposes, formed by Society of Arts, 9002, 9045-9047.

Small amount of science instruction in, previously to 1852; Huddersfield was one of the best, 9017-9027.

Since the establishment of classes in, there has not been much progress, 9045.



FOSTER, P. LE NEVE, Esq.—cont.

*Practical Instruction.*

Society of Arts' examinations are not practical, 9004, 9005.

In mechanics' institutes there was hardly any practical instruction before 1852, 9017-9027.

Students in mechanics' institutes would attend classes which provided practical instruction, 9028.

*Science.*

Instruction in, encouraged by Society of Arts, 9001-9007.

The science system originated by Society of Arts has been properly carried out by Science and Art Department, 9009-9016.

Little scientific instruction in mechanics' institutes before 1852, 9017-9027.

*Science and Art Department.*

Before establishment of Department, science instruction was encouraged by Society of Arts, 9001, 9002.

Society of Arts' science examinations now handed over to Department, 9002-9007.

Beneficial effect of Department system, 9008, 9014.

Department has properly carried out the science system originated by Society of Arts, 9009-9016.

*Science Classes.*

If classes for practical instruction were formed in mechanics' institutes students would attend them, 9028.

Teachers of, should be tested, 9037-9041.

FORSTER, P. LE NEVE, Esq.—cont.

*Science Examinations.*

Society of Arts' science examinations are now handed over to Science and Art Department; carried out on same principle, 9002-9016.

See *Examinations.*

*Science Teachers.*

Qualifications of, should be tested, 9037-9041.

*Society of Arts.*

Encouragement of science instruction by, before establishment of Science and Art Department, 9001, 9002. Union of mechanics' institutes under, 9002, 9017-9027, 9045-9047.

Science examinations of; now handed over to Department examiners; preliminary test for candidates, 9002-9016, 9035, 9042-9044, 9048-9052.

The Society of Arts originated a system which Government might take up; this has been properly carried out by Science and Art Department, 9009-9016.

*Students.*

If practical instruction were given in mechanics' institutes, students would attend, 9028.

Preliminary test for students coming up to Society of Arts' examinations, 9035, 9042, 9048-9052.

*Test (Educational).*

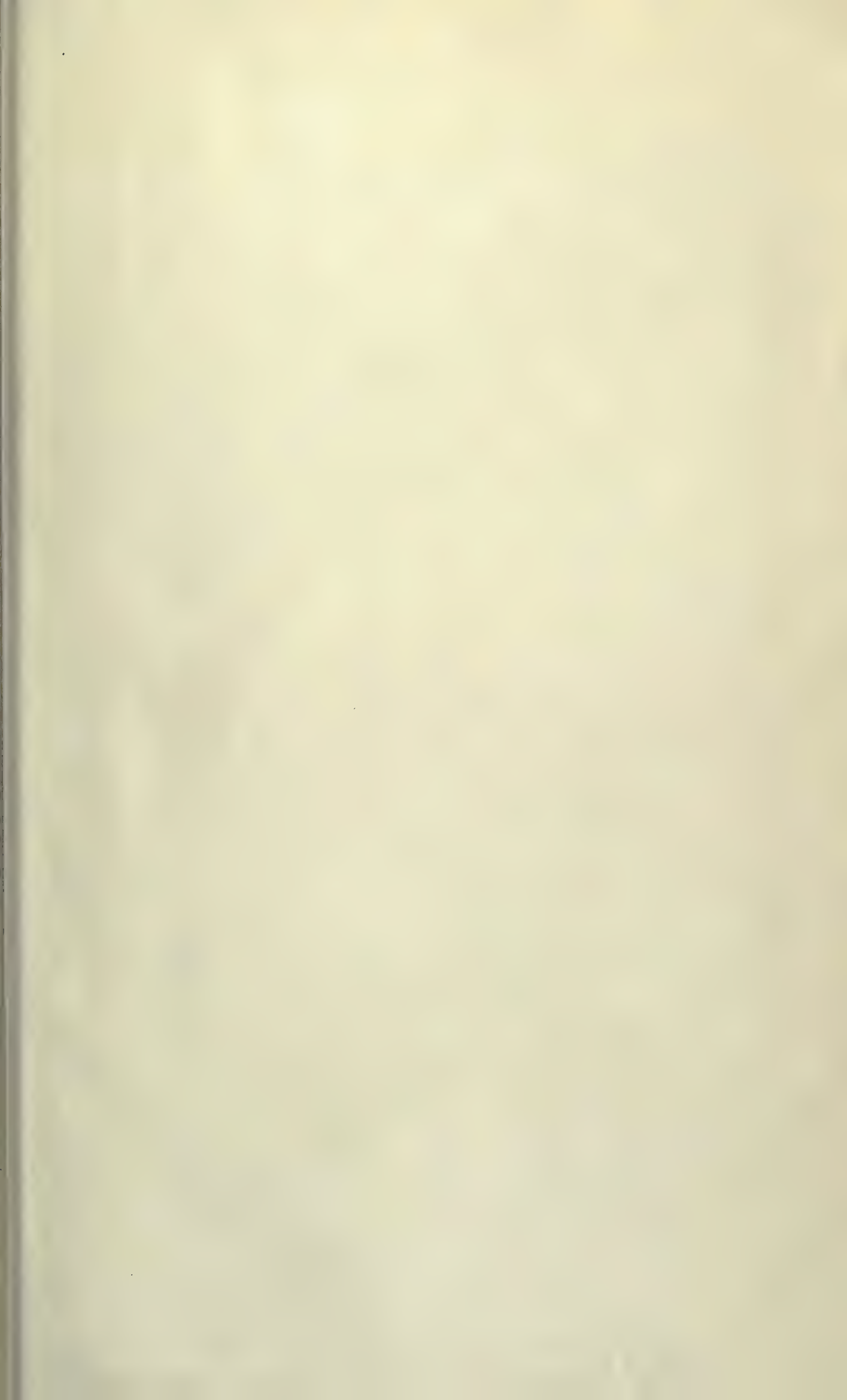
Qualifications of science teachers should be tested, 9037-9041.

Society of Arts' candidates are tested previously to examination, 9035, 9042, 9048-9052.

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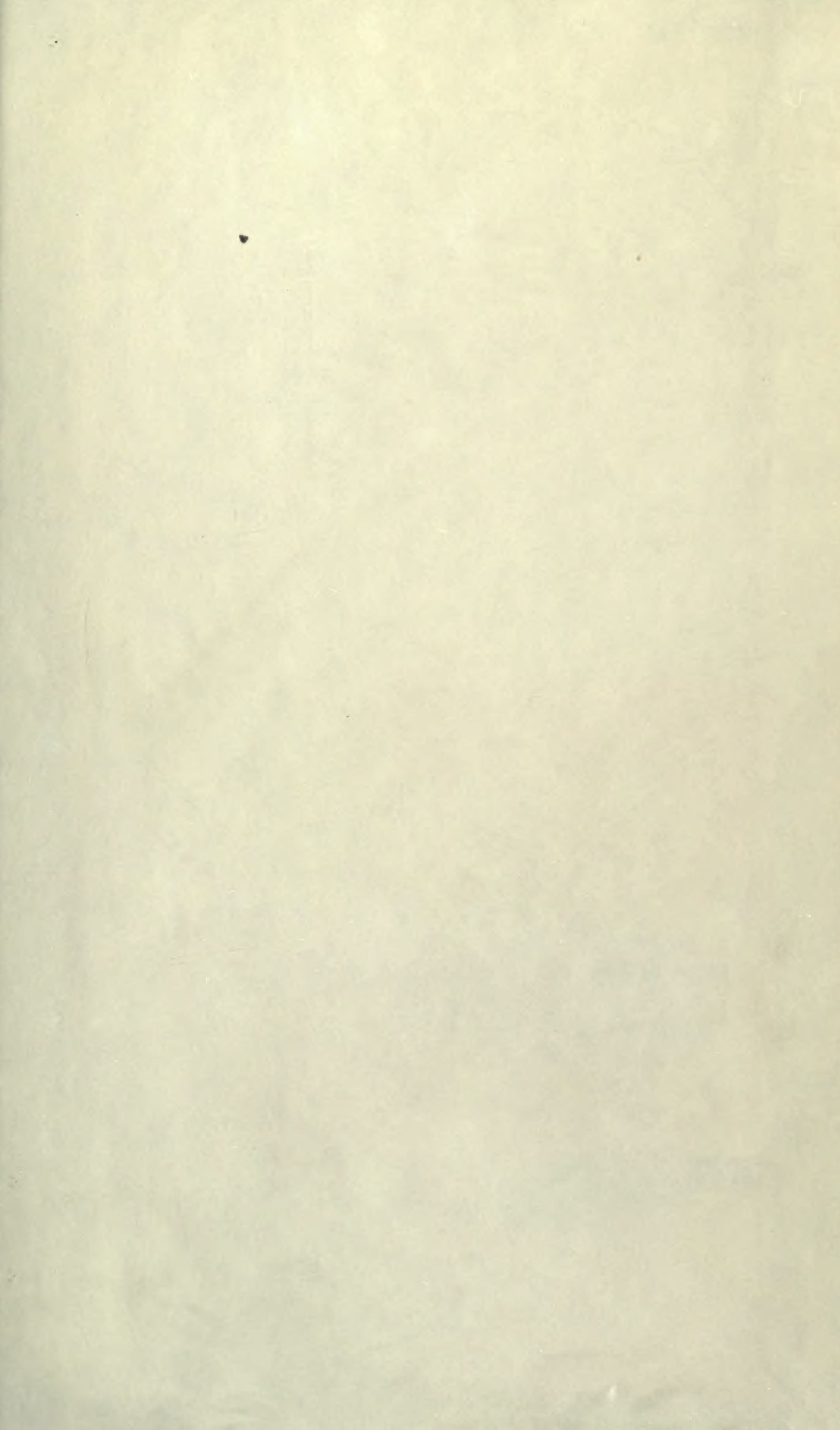


















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